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SCIENCE AND SOCIAL PIONEERING[1]

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THE classic tale has man witless until he receives the Promethean gift of fire. Light and fire are the age-old symbols of the mystery of the creative force in man or of what some would call the divine beginnings of man's discovery of a forward way. We talk less of mystery to-day for, if the source of the light of understanding is still unknown, man himself has successfully trimmed the wick. Reflected, dispersed and recombined from thousands of mental and spiritual facets, the light reveals ever-new possibilities of adventure, experiment and stimulating insight for the self-conscious creature, half angel, half brute, who talks endlessly about his elusive destiny. Whatever their own genius may be, all thoughtful persons borrow or reflect enlightening fact wherever they find it, and observe with alternating hope and anxiety the endless search by other men for that object of faith and labor called progress.

Reflecting in this fashion, it seemed to me presumptuous to express only my limited individual opinion in this opening address in an annual exchange between the British and the American Associations for the Advancement of Science. It seemed better to inquire of others what they would choose to say. Because scientists are apt to praise the children of their brains, the views of non-scientists were sought on the contribution of science to social welfare and to that uniquely human process of consciously planned advance across the threshold of experience which we may call social pioneering.

To that end I invited one hundred men who are not engaged in either physical or biological research or teaching to express their opinions. For special rea-

[1] The first British and American Association Lecture, Dundee meeting, 1939.

sons two exceptions were made. The opinions are almost wholly American; I have included those of but a few English and French friends. The list includes lawyers, teachers, artists, poets, government officials, historians, economists, preachers, industrialists, left-wing and right-wing publicists, military men, bankers and railway executives, as well as a member of the United States Supreme Court, a member of the President's Cabinet, public institutions of many kinds, men with power of command over others and men who exercise power only through ideas. With few exceptions they are men whose names are well known on both sides of the Atlantic.

Each person was asked to set down not his studied or rationalized opinion, but rather his quick and customary response to the idea that science has or has not added to man's cultural possibilities, given him a better way of thinking through his difficulties, raised his hopes for a more ethical civilization. Was his *habitual mode of thought* with respect to these propositions positive or negative?

To keep my promise to contributors the following twenty numbered statements, which combine the one hundred opinions, are given without references to sources. They are arranged in three groups—those which emphasize the gains (12), those which express qualified approval (5), and those which point to losses (3). No attempt has been made to give them consistency (compare, for example, items 10 and 5).

EMPHASIZING THE GAINS

(1) Science is to-day the most excited front of human enterprise, and such excitement is a good in itself. The fact that tens of millions of people are interested in scientific discovery and theory is one of the hopeful things in this Pandora's box of a time. Conceivably these tens of millions are or might become interested in a wider view of human affairs.

(2) The light that science has thrown on religion has made the difference between fearing God and believing in God, for it brings God within the sphere of personal experience. It has done this mainly through the removal of the fear of the supernatural. It has not lessened the force of religion by weakening the force of orthodox religion. There is neither an Acheron nor a seat of torture of souls: the shades are peaceful abodes.

(3) Science has enabled us to understand many catastrophic forces though we control or combat, with limited success, but a few. Thereby it has reduced the areas and much of the strain of ignorance, superstition and myth. Forecast in several fields has entered so effectively into civilized man's thinking that it tends to stabilize both mind and act to a remarkable degree, giving a sense of permanence or at least assurance in the midst of obvious change. We no longer cower before "the forces of nature," at least intel-
tually.

(4) Science has encouraged specialization, and sp-
cialized knowledge is the mother of invention. B
have greatly complicated life by making us all incre
ingly interdependent. In the past half century a m
titude of new occupations has grown up employ
millions whose livelihood is dependent upon multip
wants and the complexities of specialization and int
change that feed them. Science and invention, a
commerce between the less civilized and the more ci
ized peoples, have encouraged a phenomenal incre
in world population. "Back to the simple life" wo
mean starvation for many of these millions: it wo
also mean additional manual toil for almost all of
as well as diminished comfort and security. There c
be no *Erewhon*.

(5) Science serves an expanding civilization, but
do not know anything at all about our ultimate fa
the future is beyond conjecture: "the end is forbi
den." If science has introduced dangers it has al
made a net addition to human welfare by greatly e
panding man's identification and use of natural r
sources. Humboldt's dream of "enlarging the outlo
of mankind" through geographical study has be
realized: the diversities of the earth have enriched li
immeasurably. Synthetic chemistry has supplied
host of new products and opened gateways to st
wider conquests afield. Like animal and plant bree
ing, it has changed the human potentiality in, a
therefore the significance of, large parts of the na
ural environment. It has not destroyed geographic
diversity, but it has become a factor in the rearrang
ment and revaluation of diversified resources.

(6) Science insists that *facts* are indispensable i
the ordering of social change or reform. Though w
proceed by trial and error to a large extent, it is sc
ence, especially the analytical use of statistics in th
social field, that ruthlessly exposes error and helps t
restrict the areas of prejudice and uninformed pr
conception. Sentiment and emotion have their pla
in the evolution of society from lower to higher, bu
in themselves they are fallacious guides. Social pr
grams are put forward as tentatives or hypotheses i
the scientific method is followed. In earlier times o
could give categorical answers to all questions of ob
jective and meaning. Science has eliminated much o
the categorical.

(7) The effect of the doctrine of evolution upo
modern thought in many fields has come to be incalcu
lably great. It has revealed a far more complex uni
verse than had been conceived under the assumption
of fixed numbers and kinds of species that in turn ac
corded with the simplicities of the geometry and th
idealized astronomy of the Greek climax. It destroye
in time the over-generalized doctrine of universals i

ture. It weakened the hold of metaphysics upon bservational significances. It showed up the limitaons of abstract logic in discovering or assimilating uth that is either essentially irrational or subject to hange as new facts emerge and men are driven to ake "a fresh examination of particulars," as Francis acon phrased it. It gave new meanings to both scince and society by its revelation of a body of knowldge that drew its ordering from the historical record f the origins and evolutions of types correlated with he geological time-scale on the one hand and with xperimental results on the other.

(8) Many of our social problems are ethical, and in his respect the common man is perhaps the equal of he intellectual in balance, temperament and insight, r even surpasses the insulated and stylized man who as the protective walls of an institution around him r the assurances of recognized social position or ealth. In these days of exaggeration, when mere olitical mechanisms tend to be worshipped as golden alves, the scientist at least knows that there is no ollective salvation of souls and no final order. It is he business of science to discover truth, not salvation. In many instances salvation comes through the emotions and they are generally inaccessible to reason: it is also in large part an inner process, as Mazzini observed: "You will not have things better until you are better yourselves."

(9) Historically, the indebtedness of economic study to natural science is two-fold: replacement of the naïve premises of classical deduction by positive data and the use of such data in facilitating the much-neglected but indispensable step in economic deduction, namely, verification. The methods and objectives of political science have been re-examined under the inspiration of scientific influence. A healthy inconoclasm has ensued and the positive approach has become dominant. Historical writing has come to have greater accuracy and objectivity, less emotion, prejudice and prepossession, and more convincing conclusions, but might not these qualities have been gained without the example of science?

(10) Public health has been promoted by progress in biology and biochemistry and by public acceptance of or demand for appropriate administrative measures. Out of the disaster of the Asiatic cholera in the thirties of the last century arose the office of Registrar-General in England over which William Farr presided for a time. Concerning that event Dr. Parkes, an English hygienist, wrote: "It is impossible for any nation, or for any government, to remain indifferent when in figures which admit of no denial, the *national amount of health and happiness, or disease and suffering, is determined* (our italics). The establishment of the Registrar-General's office in 1838 and the commencement of the system of accurately recording births and deaths will hereafter be found to be, as far as the happiness of the people is concerned, one of the most important events of our time." During a discussion in Parliament in 1875 on the Public Health Act, described as the most complete code of sanitary law in existence, Disraeli said: "The public health is the foundation on which repose the happiness of the people and the power of a country. The care of the public health is the first duty of a statesman."

(11) The scientific attitude of mind is indispensable to further social progress, but scientists should be more modest in their claims. However closely one investigates and measures there is always a gap at the end to be jumped by the imagination. The gap can be narrowed considerably by careful thought, but after that one wants just knack or nose. Truth is deep down, said Democritus. In social applications of science one should be mindful of the precipitate of human experience which tradition represents as well as of the conflicting solutions and assumptions which we have inherited. Science itself does not supply adequate motivation for dedicated and unselfish living, living on a high level. If a scientist has these qualities it is because he is something more than just a scientist. Science has given a vast number of material satisfactions, but where has it left public thinking with respect to the heroic struggle without which a people has no fiber, no victory?

(12) Humanitarianism and democracy stand in the way of wider applications of science to social problems: they have permitted an enormous increase of population, with a rising proportion of biologically unfit and a rising standard of care for the unfit. Civilization may be too much for *Homo sapiens,* but at least we keep on trying, and science is one of the ways of trying. At times the growth of large corporations has also stood in the way of wholesome social change. In the absence of any clear philosophy of control by society they grow past the bounds of public knowledge. While they have had well-known beneficial effects they also permit a modern form of ruthless raiding. A democracy is required that not only gives economic and political opportunity but also treats men as ethical and spiritual beings.

Qualified Approval

(13) Science, largely by its emphasis upon the freest and widest inquiry, has aided in the diffusion and acceptance of the principle of religious and racial toleration, but there is grave doubt of the strength and permanence of this gain.

(14) Lord Kelvin's remark that "you do not know much about a subject until you have tried to measure it" is clearly applicable only to that which can be measured. Science deals quantitatively with measurable material things and less with *quality* which sup-

plies the essence of culture. With its emphasis upon a mechanistic theory of inevitable law, science has acquired a prestige that can be a real danger. The crucial question is, what has science done to enable the individual to *see* the pattern of his ideal more clearly and to *fulfil* his new vision? Measurement and accuracy do not touch even the fringe of social questions. The totality of human affairs (ideas, beliefs, conduct, habits, institutions, etc.) can not be reduced to deterministic sequences. Knowledge of facts does not tell us what to do about them. *Social action is based upon assumptions, expressed or implied, respecting human values.* Science helps indispensably, however, in its zest for truth, for careful observation, for an even-tempered attitude.

(15) Science has shrunk the planet, close-knitted civilization, and practically revolutionized life. Once we thought it remarkable that *news* from all over the world got to us each morning; now the distant trouble itself is at our door. While our curiosity has been widened, will any one claim that our sense of responsibility has been enlarged? Are we usefully informed or only distracted? A high degree of accuracy has been attained by news services if methods and time limitations are taken into account, with the result that "public opinion" has gained a status not unlike that of a world conscience. The dictators always lay hands first upon radio, cable and newspaper. They wish the rest of the world to be unaware! Two chief difficulties delay the realization of a better international order: (1) the increasing dependence of individual welfare upon a limitlessly expanding number of other individuals unknown to him as persons; and (2) the creation of an unbelievably complex web of human ordering beyond our present means of guidance.

(16) Very few people know anything about or care about science in a fundamental sense. The better a product becomes and the more widely it is used the less public interest is shown in its origins and mechanism. It is the esthetic factor that now counts most in a motor-car: all cars run well. The public will continue to accept the findings of science but, if pushed too fast in the direction of new social schemes called "scientific," they will become frightened. Our time span for social change is now much shorter than formerly. In an earlier day more time was given to absorb change without conscious direction. Hair-trigger thinking is now fashionable in the social field, with action but an instant behind, and the revisionary habit of science applied to such thinking would have a desirable sobering effect. At present, applications are left to mediocre minds. Shamefully little progress is made towards the solution of basic social problems such as housing, access to medical care, stabilization of employment.

(17) Universal education offers the only hope of establishing in the minds of the people the minimum conclusions of science that bear on social welfare most directly, or appear to do so. These minimum conclusions can become the blueprint of social engineering only if they are kept within the range of mass thinking. That range, in turn, is limited because human desires are dynamic and simple, while human intellect is telic and complex. Desires propel, intellect can only feebly guide. "People" see the *things* of science and forget the *discipline*. Their minds are littered by ideological concepts and dogmas, incapable of verification, that stand in the way of acceptance of a scientific approach to social problems.

LOSSES

(18) We live in "the dark hour of a gifted age." Science has made war more terrible; it has debased mankind by its growing disregard for helpless and innocent non-combatants; it has forced the whole of civilization to adopt the most horrible methods of destruction. Men have tried to agree not to use the worst instruments of warfare, as the Church once tried (1139) to anathematize the use of "the deadly and hateful art of crossbowmen and archers in wars against Christians and catholics"; but in the end each new frightfulness triumphed.

(19) It is a clever, cynical and hard-bitten world that science is making, one in which the idealistic and the spiritual are bound to have a diminishing place. Viewed against a background of classical education science has been a disadvantage to our society. If the most important questions of mankind are those concerning spiritual relations with one another and with God, then science is not to be taken seriously. Through dazzling discovery and successful practical application science gives a sense of power that is both demoralizing and dangerous. We are given an enormous driving force that does not permit us to be as bad or as foolish as we could be with impunity down to the middle of the eighteenth century. The impact of science on our morality, individual and national, is evil unless we rise successfully to the test of our character and moral traditions. Science has taught us analysis, but we have had as yet no large-scale and equally successful synthetic constructions that bear on human conduct. The mass mind seizes and acts upon perverted ideas of scientific generalization. Darwin's "survival of the fittest" encourages men to be brutal; Freud's "don't repress," to indulge their passions; Einstein's "relativity," to think that truth doesn't exist and doesn't matter.

(20) The fickle wishes and caprices of men, in economics and government particularly, have been given weight and apparent rationality by the adoption of unsuitable methods devised by technocrats accustomed to weighing material objects. To limit oneself to

"data" in social studies is to parody society. Human science must think of life as a whole. The riddle of life is not in objects or discoveries without, but in conscience and mind within. A man's "destiny" is what he can make out of his own character.

"Science" is not a Universal

In weighing these responsive observations one does well to keep in mind that what we call "science" is largely though by no means wholly a conscious intensification of methods and results that had exceedingly remote origins. Science is a part of human life, not something separate and distinct. Farmers of all centuries, fishermen and especially sailing folk—all have developed science of a sort: empirical observation, limited analysis and generalization, confrontation of theory (idea) with fact, as well as revision or modification (with much myth and nonsense built in too). The methods were not labelled or systematized, cause and effect were often wrongly ascribed, but the result was progress by taking thought.

It does no good to vaunt science as if it were something that stood above the rest of knowledge—independent, self-sufficient, worshipful. As human experience, science is not a universal, a summation of knowledge applicable and useful to the whole of life; it is rather a thing of limited categories. Science gains nothing by the decline of humanism: it is itself a special form of humanism. One asks, what is its net worth in the sum of human interests? What does it add to education, to outlook, to citizenship? And especially what does it add to human possibilities, to spiritual incandescence?

No claim for science may be set up without pointing to the limitations of scientists as individuals in responding to prejudice, group opinion, and the like. To most scientists, science is only a specialized form of experience. When a scientific man turns to the social framework which contains his science, conditions it, encourages or discourages it, he is bound to take account of other elements of society than his own, other tastes, other judgments of value in life. Individual scientists are often affected by the source of their support. They will tend to approve the policies of the companies that supply them with a living. They will measure a social program by the yardstick of company prosperity. The company may be a profit-making concern or a university.

A scientific career, so-called, does not necessarily make its devotees broadminded, cautious of the word, modest in spirit. It takes more than science to widen a narrow man's sympathies! Science does not in itself "turn the common thoughts of life into gold." Few scientists have the power of persuasive exposition; many have "the gift of infrigidation." Scientists have no monopoly of the power to discard dogma, the courage and intelligence to win territory from superstition. Do they call attention to the merits of scientific method "to protect their banners and slogans" or to improve society?

The Concept of Change

In so far as the methods of the physical and natural sciences teach patience, establish the value of both imagination and doubt, enhance analytical power, and provide training in observation, they are of value in any study—crime detection, historical inquiry or the rise of contemporary social movements. But these are not powers newly acquired by scholars in our scientific age. They have always marked all research and insight, in antiquity as in recent times. The poet shares them with the scientist. What biology and geology have done is far more distinctive and new in thought than these qualities denote. They have made the Greek "all flows" not only a matter of time, but also a matter of form and function—change as *the mode of the universe*. How and why things change is at the core of scientific inquiry, not alone how things are.

One of the greatest achievements of science is its emphasis upon free inquiry—the mind itself in command, driven by curiosity and the sense of intellectual adventure. The motive force in an earlier day was faith which removed "not mountains only but the whole material environment." Facts and events were removed from the realm of human action to that of divine grace. Theology and philosophy have since been modified, largely by the light of modern science. Evolution has required every intelligent religion to reshape its view of man. Recent pragmatic philosophy would have little substance if the evolutionary concept were subtracted. After 1860 historical writing clearly showed the effect of the evolutionary approach; and economic theory dealt increasingly with the problems of a dynamic society. The doctrine of evolution involved the minds of men in what can be conservatively described as an overwhelming revolution. In the eighty years since the "Origin of Species" was published no thinking man has escaped its influence.

The concept of evolution influenced some areas of thought long before the modern doctrine of biological evolution was formulated. It was a maxim of Roman law that the limit of the law is its greatest injustice. To codify the law and put it into "tables" represented progress; but it was greater progress to take it out of the tables again, so to speak. Precedents had been proven to be not enough; ethics and public utility were asked to determine forms, and ethics and public utility change with time and circumstance. The whole body of Roman law reflects an effort to apply reason and fairness to a changing society to be accommodated by an elastic set of rules in which the danger of defini-

tions was pointed out. Principles were made to rest on experience; they were "rooted in a philosophic consideration of human life."

In the natural world no such progress was made in Roman times, and indeed we do not see how it was then possible. Lucretius showed what science (as he understood it) could do, but he was unable to make practical proposals for social applications. An understanding of nature would drive fear out of the world, said he, and a better knowledge of both nature and the gods would help bring peace and honor to men. Only as late as our time could the principle of evolution be so variously documented that the idea became accessible and interesting to all men, not the vision of a few. Each specialist came to see fruitful applications in his own field. Dynamic change displaced ideal pattern, fixity and immutability. Lawyer, economist, historian, geographer, priest, chemist and statesman could speak a common language of movement, of continuing adaptation, through nature and through interactive society.

Diversities and Contradictions

Civilization may be usefully considered as an adventure in change. New forces are generated through the evolution of tools, the domestication and subsequent breeding for quality of animals and plants, through age-long folk experiment and through the occupation of new lands with their diversifying possibilities. Each people carries on the adventure in a different way because of its distinctive regional environment, its unique aptitudes and its variant objectives and philosophies.

The diversities of time, place and race may also raise barriers to understanding. Confluent in trade and travel we are nationally divergent and often discordant with respect to philosophies and ethics. Our rules are not the same, in Asia and America. Our languages are no more unlike than our systems of logic or our definitions. Our ethics and our judgments also change in time. It is sometimes said that ethics and manners are matters of geography. In this fluctuant world the geography changes rapidly also, because as man changes his techniques, his tastes and his systems, so also does he change the *significance* of much of his environment.

The main job of some schools of agriculture is to raise food-production per acre. This is condemned by those who say that we grow too much food already. It is praised by those who, as in over-populated Puerto Rico, are trying to get the value of food crops per acre raised to the level of the sugar crop, now 800 per cent. above food crops in value! The Netherlands East Indies tries to meet the reduced demand of world markets for her staple crops (rubber, sugar, coffee) by new crops—tung oil from plants imported from China, tanning material from an Acacia imported from South Africa, wood-pulp from imported pine trees. The ultimate values and distributions of men and resources are unknown to us: we suspect there are no ultimates. We keep learning in the hope of achieving net improvement for the time being. We have also learned that to learn is generally to change.

Most public discussion is babble about agriculture, industry, health, education, security, employment, taxes, war. The voter is asked to express opinions on a jumble of political and social programs by casting *one* ballot. One item in the bundle may be desirable, another highly undesirable. What effect will an act in one field have upon desired ends in another field? The whole must be dealt with, and the individual knows only a small part.

Specialization Increases Satisfaction

Science and much dependent invention has added to our material equipment to so great a degree that it has given "standard of living" the magnitude of a major social force. The individual desires to possess maximum satisfaction, and nature is explored, invention hastened, productive techniques refined to that end. Public health is improved and education made general, in order that life may be more *satisfying*. Fabrics of high utility and pleasing color and design are now available at more generally attainable prices than formerly. The illustrative arts have opened new worlds of enjoyment to millions. Photography alone has vastly increased the satisfactions of mankind. The gains in food production are revolutionary. Quick-ripening wheat and rust-resistant wheat represent two epic breeding struggles with billions of dollars worth of human welfare at stake in the empire of the Canadian Northwest alone.

Let no one dismiss the gains of science lightly with the word "material," as if that didn't matter! We can not overlook the unrelenting fact that all but a few of the people in the world *must* think about food and clothing and power, muscular and otherwise, in order first of all to live. Only a protected life provides the time and strength for continuous thought about meanings, discovery, philosophy, esthetics. The genius alone may be an exception—the miller's son who became Rembrandt, the ploughman Burns.

The scientist no less than the humanist sees the smallness of the spiritual gains in deplorable contrast to the material benefits. What we are trying to do, said one who helped develop Crater Lake National Park, about the forested rim of a high circular bowl in which lies one of the loveliest of the blue waters of the world, is to offset speed. When it took a day to reach the place, people enjoyed it, after earning their enjoyment. Now they rush up to the top in an hour in swift motor-cars, dash to the rim, gasp, "My God, how blue it is!" and rush right down again!

The Edge of the Possibilities

Science has become one of the greatest of the adven-
es of our time partly because it deals with the edge
the possibilities. Man was always working to push
t limits, but much new knowledge, and vast organi-
ions in our day have speeded up the process. Man
also discovered that he is changing his own pos-
ilities as well as those of his world as he goes along.
is at the center of his own creative experiment.
has found that what science supplies is not at all an
dition, positive and beneficial, until men have proved
so. The whole of that proof is in man himself and
in admiring regard for new facts and inventions.
ings and forces, social and natural, good and bad,
added to himself, with the result that ever new pos-
ilities are emerging.

Land pioneering to-day illustrates two such inter-
ing forces—the edge of the possibilities (marginal
d) and the desire for an acceptable standard of
ing. The limits of land cultivation are being traced
ther and farther afield. But what is left of pioneer
d in the twentieth century is marginal land whose
nquest requires both knowledge and better material
uipment. The pioneer, seeing himself as part of a
der community, asks for a share in the total benefits.
If he is to be empire builder he wants his reward here
d now. So, let government do it. Roads, schools,
legraph lines, favorable freight rates, market facili-
es, low taxes and security from undue risks to health
the frontier are demanded! The protection of chil-
ren brings restrictions, limitations, conservatism.
Things must get better in time or too many families
ill become habited to the backward look to optimal
gions.

Science here serves as a supplement to marginal
ature—what crops are adapted to uncertain rains, or
te-spring and early-autumn frosts, long haulage and
istant demand. If the frontier environment can not
e supplemented, social deterioration will take place.
It is not enough to push people out upon the land if
he land is marginal, risky, remote. Civilization must
accompany the settler. Finally, the intending settler
must have the will to succeed and he must have the
apacity to adapt his musculature to new physical
asks, his mind to the possibilities of new cultural
(social) experiments on the frontier, his enterprise to
he potentials of the land and the region. If spirit is
wanting, if security and accustomed ways are indis-
pensable, if adventure is dead within him, the frontier
s no place for him, with or without science.

New Frontiers in Old Communities

In the United States applied science has increased
agricultural production per worker, through machin-
ery and fertilizers chiefly, and speeded transport, with the result that agriculture has become dominantly commercial and competitive, with marked changes in crop production and type of farming in many regions. Civilization has become increasingly urban, with resulting weakening of both family ties and the neighborhood bond. Machinery has helped create more commerce, more striking and more numerous economic successes and a much higher standard of living for certain classes. Billboards on the highways tell youth that it is "entitled" to a good car, good clothes, a good time. Whether or not that entitlement was earned, what responsibilities go with it, what the advertised product will do to strengthen character or enfeeble it—these things are not put upon the billboards.

We have learned how to feed and breed animals to a high level of efficiency. We expect six thousand pounds of milk a year from a single cow to-day, whereas a hundred years ago two thousand pounds was the average. We know how to preserve food for long transportation. We successfully combat many plant enemies. We have done work upon the grasslands to preserve and improve them, upon soils to determine their rate of wastage and the extent of their need for conservation, upon fisheries as a food source for man. We have calculated the amount of ocean that will be required to sustain a man: a volume of sea water approximately equal to that of a football field covered five feet deep with water and requiring two and a half hours to filter out the zooplankton. If the result seems economically not feasible, science may yet find a way to strain sea water in the likeliest places and provide additional food. Here taste and preference may step in. Will a breakfast of copepods become popular even though we know that they are equal to the best meat in nutritive value?

The triumphs of a scientific age have coexisting population problems of a disturbing character. In the large cities of America there are now about 7 children to 10 adults. If our present reproduction rate remains stationary these 7 children would raise 5 children and the 5 in turn would raise about $3\frac{1}{2}$. The middle class in the cities consistently diminishes its stock. By contrast, the farm population raises about 14 children to 10 adults; the 14 would have at the present reproduction rate about 20 children and the 20 about 28. In 1937 and 1938 the "farm-baby crop" increased, the total for 1938 being the largest since 1926. How long and with what stock will the farm help populate the city? Not enough children are being born to maintain the existing level of the population of the United States. Already the enrolment in the first grade of the public schools has fallen about 100,000 a year since 1930. In the six elementary grades it is declining about 200,000 a year.

It is not easy to point out offsetting conditions to

farm population decline. The electrification of farm operations, the development of credit unions and producers and consumers cooperatives may restore a sense of mastery to and lay a basis for cultural participation by those who are drawn into the struggle that tends to pull good stock to the cities, there to confuse and devitalize it culturally, morally, economically. Between 1790 and 1930 our rural population increased twenty times, while our city population increased three hundred times!

The play of the forces involved in these far-reaching movements and cultural changes, whether self-initiated and free or guided by government, denote a pioneer fringe of high interest in the social field. The situation needs vital leadership, courage and local pride as well as equipment and the experimental point of view. These are old-fashioned virtues and they imply the hard way. Can our entire population rise to such Spartan levels, to self-denying activity, to ideals of independence and strength that evoke dynamic enthusiasm?

Individual and Group

It is a fallacy to suppose that *group energy* is the sum of the individual energies in the group. A man does not make war: a nation or a tribe makes war. A citizen with a gun and no license and a soldier with a gun have two quite different social prospects. A group approves group action which it may condemn in the individual. Our social ethics are not consistent with our personal standards. We are caught up by our generation in the world at large—its ideas, its wars, its conflicting loyalties.

Our culture has developed dysgenic rather than eugenic qualities. Success and its social rewards, implying unusual intellectual and other social capacities, have become linked with diminished fertility. The well-endowed are not reproducing on an adequate scale. This means a steady diminution in the supply of the inherited qualities that brought success. In so far as success is spurious or anti-social the loss of these inherited qualities need not be regretted. In so far as it represents socially valuable qualities it means continued erosion of human character and loss to the race and to civilization.

We are wanting in general acceptance of categories of socially useful qualities. "Eureka, I have found it" means nothing socially until all have found it. "The genius raids . . . the common people occupy and possess." Whatever we gather of scientific knowledge concerning society and how it might be improved is one thing; to persuade or to exercise control in order to bring about desired ends is quite another.

We say that youth should be taught to acquire power to adjust itself to associative living. To a large extent this means the acceptance of the standards of contemporary society, the routine encouragement in oneself of that which society encourages. To carry this out to the fullest extent might be to destroy individual gifts and powers. Social living is not all! Will society foster or permit the not-understood individual variations that include the genius?

The supposition that scientific discovery can be made to bear immediately upon social change, the scientist remaking society, seems faulty doctrine. "Society" is built upon beliefs, traditions, prejudices, suppositions and philosophies, as well as facts, institutions, inventions and materiel—all supported by power or force exercised through *time*. Every advance in applied science calls for a tighter and more inclusive social organization, and it is the state which inevitably controls that organization. In exercising its controls, the state (consisting of determined *groups of men* who hold power, no less than accepted but precarious forms of controls, institutions, and the like) may introduce only those discoveries that suit its book. The holders of power, to whom power is the first law, will scarcely legislate themselves out of office. Moscow, Berlin, London and Washington are alike in this respect.

What is unlike in these four countries is a far more profound thing—the relative degree of freedom for the individual in finding and proclaiming scientific discoveries and in *advocating* their social applications or acceptance. The fight for adoption or rejection of ideas is in the open social arena in democratic countries. If there are dangers we are free to denounce them: no philosophic theory of society stands in the way. By contrast, if it suits the dictator to rest his social argument upon the powerful effects of an improvised environment he rejects the findings of geneticist and eugenist and even a Vavilov loses his job. To be secure as a scientist in a totalitarian country one must first ask a political bureau what is sound.

Let no one suppose, however, that democracy ensures continued freedom. Only when democratic social control of economic life is fully extended shall one be able finally to test the hypothesis that freedom of learning can live in the house of democracy. If the gap between "knowledge" and folk thinking gets too wide we shall all have to turn to the forging of a common method of thought, with no small risk to be run that a sterile generalizer with power may impose a philosophy. This makes the conservation and freedom of the minority a vital need: how often has a single vigorous challenge saved a human situation!

Planning Involves Risk

The tentative nature of social conclusions is often a deciding factor in the rejection of scientific findings. Rightness is not proved except through social experiment that is jeopardized by too short a period of trial, by misrepresentation and misunderstanding of effects,

y the fact that the objects of experiment, men and omen, care for different kinds of outcome and such aring may change the outcome. Speed in social re-orm itself creates a kind of road hazard because of npredictable turns and their effects, unforeseen mpacts and disturbances.

The long view and the short view are difficult to istinguish—a further complication. To preserve our ivilization we strengthen our nation, pointing to the ompetitive situation in the world at large. Through ational planning we seek to raise the level of health nd strength, to solidify national interest. This will nevitably have the effect of intensifying international ompetition. Commerce is increasingly competitive nd necessarily implies inequality of opportunity in pecific lines. In a wide sense commerce is the mother f all wars.

In the international field the triumphs of increased ome production, ersatz and autarchy, hailed one by ne as proof of growing independence and enhanced elfare—all are advantages that are bought at the rice of dislocations elsewhere. Many a national tri-mph implies a setback for some other nation.

Identification of Causes Precedes Control

Social pioneering has to do with culture in the mak-ng, with environment that becomes understood by hinking about the conditions of trial and the effects of rror. It deals with inevitably new social forms or ld forms adapted to new situations, and becomes ever ore complex and overpowering for the individual. Faced by an emergency we develop emergency mea-sures only to find ourselves shackled indefinitely by the emergency forms which we set up, "thereby covering up the conditions that necessitate them."

The first duty of an intelligent society in the modern scientific period is to get at the causes of things. The increase in the general consciousness that wonders exist, that science can create marvels, and that science supplies valuable elements in social living is a gain of the first importance. It has taught whole peoples to look for causes or to expect that causes will be found. Man's greatest hope lies that way to-day. Once causes are located there is no guarantee that a situation produced by a given cause may come to human control. But there is at least *a chance!* Any gains made in this field have appealing potentialities: a basic discovery generally leads to a host of derivative discoveries.

The scientific method is needed nowhere so much as in the sorting of causes and the delimitation of the action of forces supposed to be at the root of our troubles. The United States Bureau of Investigation reminds the Boy Scouts that though they number 1,281,000 they are outnumbered four to one by the 4,750,000 murderers, thieves, burglars, embezzlers, arsonists, kidnappers, extortionists and other criminals. Equally the criminal hosts outnumber the college population of 1,200,000. The director of the bureau does not find the cause of this appalling condition in science: he points to the skulking despoilers and modern-day pirates, "the venal and corrupt politicians" who place personal profit above the rights of decent citizens. But what does he find in the decent citizens themselves? Apathy, lack of interest in honest law enforcement, laziness in the exercise of the power of the ballot. The underworld counts upon these qualities!

A recent advocate of "glandocracy" contends that a society is as good or as bad as its nervous system and its glands, which together make an integrating mechanism whose character profoundly conditions the individual and his attitude towards the society of which he is a part. Given a harmoniously integrated development and the instinctive reactions to good social conditions are more likely to be adaptive and harmonious. Too simplified and mechanical an explanation, one may say. But in any event science deepens the understanding of basic conditions, and searches endlessly for causes in the hope that once they are found a clue to control may follow.

Breaking the Frame

In man's endless adventure in progress, are the objectives to be great works of art, literature and science, or the development of personal health, strength and hardihood joined to national conquest, thereby exalting the nation at the expense of the individual? Or is it sufficient to promote the glory of God by confession, by religious adoration?

Modern science is not without its infective transcendentalism. "Our destiny is in our hands . . . develop all [our] potential activities . . . reject all systems," says Carrel, who believes we can achieve almost illimitable social advance if we but give scope to feeling and genetic possibilities. He advocates resistance to "the tyranny of the quantitative." He would break the frame of the school, the factory and the office, and reject the very principle of technological civilization: mechanical inventions but hinder human development. This seems to overlook certain prime and as yet ineradicable troubles of mankind, such as divergent and conflicting aims, faults of organization, lack of wide social participation in the findings of science.

How resolve the conflicts between classes, reduce the arrogance of nationalism and diminish the chances of war? Which class is to benefit most from a given program, which nation? Are these questions any nearer settlement because of our present wealth of scientific knowledge? Would more scientific knowledge decide the correct and just apportionment of advantages and

privileges and accessions to the forces that raise the standard of living? Without modern scientific knowledge would acceptable solutions be any nearer?

Justice to conflicting groups requires either agreement between them or a universal judge. Our sympathies are weak when we try to put ourselves in the places of men who are far away. We rationalize our own acts to make them good to us and those of the enemy to make them bad. When we fight for the good against the bad it is war nevertheless. Science should provide an even-tempered attitude, but it seems almost superhumanly difficult to cultivate it in society.

We believe in scientific progress, but we reject the findings of science if they disturb an existing going concern, a satisfied community, an assured communication method. We can see only a little way ahead. This produces caution in some. Others exclaim, "if there are remote consequences let our progeny struggle with them." To feed unemployed people we incur a debt. We assume that the fed are worth feeding, knowing that a good deal of unemployment is non-discriminatory. We say that a minimum degree of support is required for an unemployed person, but is not "minimum" determined by worth? If we needed more people would not "worth" rise? Will our children be willing to use the lesser wealth of their time to pay for the judgments of our time? Or do we act like the worker wasp that, when the food supply runs low, bites off the tail of the grub to feed to its head?

In the midst of our troubles, the endless search for simplicities goes on! The despairing layman's answer to the complexities of phenomenonology and doctrine is to set up or accept a new doctrine that is simple and clear and based on authority. There is a clamor for simplicity in economics, politics and education. One hundred books will educate you, and all educated men will then talk alike; a formula can surely be found to break down the barriers to unemployment; if all nations would embrace the principle of world cooperation we should have peace. Editorials, columnists' comment, articles, adjuration, philosophies, tend toward simplicities: ha! here at last is the prophet who has found a way!

There seems to be no straight path to a social goal; evolution seems chancey; progress is only a fitful by-product, says the despairing observer. Our loyalties waver, our beliefs change, our confidence in accepted democratic methods is impaired as we observe the wide variation of intelligence, the difficult task of sustaining interest in community affairs, the low level of individual satisfaction, the little knowledge we have of our leaders, the prime difficulty of bringing democratic method down from a glowing historical abstraction to a concrete activity, the inevitable performance of many functions of government by individuals employing their own judgment, the large element of guesswork in all forms of experiment, including social pioneering, the difficulty in distinguishing between true and false results in short or long periods of time, the haphazardness, the waywardness, the *lack* in democratic judgments, perceptions and actions. To offset these tendencies we offer education, more science rather than less, and "a documented call for action" based upon agreement as to facts by social scientists. Little enough, one must admit.

Analysis and Advance

Social forms can not keep pace with creative thought. A time lag is inevitable because we have found no way to teach and test ideas except through time-consuming and often inconclusive experience. No one subject of study is capable of solving the total array of problems of a people. Science is no more deficient in this respect than social studies themselves. Hear an economist: "Economics is not the science of welfare . . . it is concerned with the relationships of scarce means to given ends." Economists may formulate economic policies through the application of reason and systematic thought to a limited field of human relations; but economics can not provide a total social program, continues Mackintosh. Even the data and hypotheses of economics are limited to a particular age. The subject tends to become less general in its application, a doctrine rather than a science.

In the last quarter of the nineteenth century, modern economic analysis (Marshall, Jevons, Menger and Walras) found a tool of investigation whose focus is the principle of equilibrium and its use has been continuously extended "to attack equally problems of disequilibrium." When the economist is finished with his statistical analysis, he adds imagination, experience and reason to create and test his hypotheses. Are there institutions to carry out an indicated policy? Will the democratic group for which it is designed understand it, accept it and expand it to fit changing conditions? The ends that society has in view are constantly changing and only rarely are they precisely defined. The problems themselves are complex and so, too, are the methods by which they will be solved, whereas public attention is short-lived and public analytical power is extremely limited.

Directives and Limits

From the evidence of paleontology chiefly it was discovered that life from the first had both plasticity and the potentiality of change. Whatever the underlying causes and mechanisms, increasing complexity of form and function has been life's mode. Both muscular and psychological complexity has given organisms increased power (efficiency) in the *use* of the physical environment. Will the process stop with defeat at the physical and psychological assembly known as man, or

will the conscious human turn his unique power of understanding upon himself, both as an individual and as part of a social mechanism?

Faith and method joined to imagination and curiosity still lead us on. Science is the greatest inciter of hope that we know—rational hope that the triumphant methods that have given us deeper understanding and increased efficiency as biological and social mechanisms will one day give us a still deeper insight into who and what we are and what we may become when rational control is extended. As in art and religion so in science—new meanings evolve as the mind continues its unshackling process. The eternal is not brought down from aloft only: it is also sought out and raised up among men. Science is one way of acquiring a knowledge of meanings or of adapting or inventing meanings that give deep human satisfaction—for a time.

OBITUARY

ARTHUR EDWIN KENNELLY

With the death on June 18 of Dr. Arthur E. Kennelly, professor emeritus of electrical engineering at Harvard University and the Massachusetts Institute of Technology, electrical engineering lost one of the pioneers who began his professional work when the only practical application of electricity was its use in simple telegraph circuits, but who lived to see the art reach its present highly developed form. His unusual ability, his industry, his gifted personality and his many important contributions to the development of electrical engineering gave him international recognition as a scientist and a teacher. His career was contemporaneous with those other great contributors to electrical engineering such as Heaviside, Edison, Steinmetz, Elihu Thomson, Sprague, Houston, Brush, with all of whom he was more or less closely associated in his professional work.

Dr. Kenneily was born at Colaba, near Bombay, India, on December 17, 1861, his parents being David Joseph Kennelly and Katherine Heycock Kennelly. He was educated in private schools in Great Britain, France and Belgium, and especially at the University College School, London. He was definitely attracted to a telegraph engineering career by attending a public lecture in 1874 at Albert Hall, London, by Mr. Latimer Clark on "Submarine Telegraphy." In 1875, at the age of 14, he was appointed assistant secretary to the Society of Telegraph Engineers (later the I. E. E.), London. In 1876 he entered the submarine cable service of the Eastern Telegraph Company and for several years was engaged in the laying and repairing of submarine cables between England and India, rising to the position of senior electrical engineer in 1886. In 1887 he became associated with Thomas A. Edison in his electrical laboratory at Orange, N. J., remaining his principal electrical assistant until 1894. In 1893 he was made consulting electrician to the Edison General Electric Company and the General Electric Company of New York. From 1894 to 1901 he was a member of the firm of "Houston and Kennelly," consulting engineers. In 1902 he was engineer in charge of laying a submarine telegraph cable for the Mexican Government from Vera Cruz to Campeche. The same year he was appointed professor of electrical engineering at Harvard University, which position he held until 1930, when he retired as professor emeritus. He was also professor of communication engineering and director of electrical engineering research at the Massachusetts Institute of Technology from 1913 to 1923, becoming professor emeritus in 1930.

In 1903 he married Julia Grice, of Philadelphia, who died early in 1935. A son, Reginald Grice, a chemist, of Springfield, Massachusetts, survives.

During 1918 Dr. Kennelly was a civilian liaison officer for the Signal Corps for the U. S. Army in France. He was chosen as the first exchange professor in engineering and applied science at French universities from seven cooperating American universities. Also, he was the first Iwadare lecturer to Japanese universities (1931).

Dr. Kennelly has been honored by many professional and scientific societies and has been the recipient of several medals and similar honors. Space permits the mentioning of only a few.

He served two terms (1898 to 1900) as president of the American Institute of Electrical Engineers, in 1911 was president of the Illuminating Engineering Society, and in 1916 was president of the Institute of Radio Engineers. He held either active or honorary membership in the American Institute of Electrical Engineers, the British Institute of Electrical Engineers, Société Française des Electriciens, Royal Astronomical Society, American Association for the Advancement of Science, the German Elektrotechnische Verein, the National Academy of Science, the Japanese Institute of Electrical Engineers, the American Academy of Arts and Sciences, of which he was vice-president, and many others. In 1935 he was honorary president of Union Radio Scientifique Internationale and in 1938–1940 he was vice-president of the Edison Pioneers.

Among the several awards accorded him were the Edward Longstreth Medal and the Howard Potts Medal of the Franklin Institute, for electrical research; the medal from the Société Industrielle de l'Est; the

Cross of Chevalier de la Légion d'Honneur from the French Republic; the annual medal of the Institute of Radio Engineers; the Edison Medal of the American Institute of Electrical Engineers; the Mascart Triennial Medal of the Société Française des Electriciens. He was a member of Tau Beta Pi.

In 1895 he received the honorary degree of doctor of science from the University of Pittsburgh; in 1906 the honorary degree of master of arts from Harvard University, and in 1922 was made doctor of the Faculty of Science, University of Toulouse, France. In 1936 he received the honorary degree of doctor of engineering from the Technische Hochschule of Darmstadt, Germany, on the occasion of the centenary celebration of that Hochschule. In 1939 he was elected a member of the Royal Swedish Academy of Sciences.

One of his chief contributions to applied science is a paper on "Impedance" presented in 1893 before the American Institute of Electrical Engineers. This was the first publication of the extension of Ohm's law to the complex plane and is the basis of the application of complex quantities to alternating-current circuit analysis. Another of his outstanding contributions is the application of hyperbolic functions to the solution of electrical-engineering problems. In 1891 Heaviside had given in terms of hyperbolic functions the fundamental steady-state equations for potential and current along a line, but in alternating-current cases he showed only lengthy scalar methods for their solution. In 1894 Dr. Kennelly gave the first solution in terms of complex hyperbolic functions and at the same time introduced the polar notation for complex quantities, which has come into extensive use. He has since expanded the use of complex hyperbolic angles to alternating-current lines, such, for example, as expressing the equivalent Π or T of a smooth line in terms of a complex angle θ and two other quantities. His publications, including tables of complex hyperbolic functions and charts, have long been in extensive use for the solution of line problems, by both students and practising engineers. Early in his career he developed an electrical method of localizing faults in submarine cables by varying the current strength, and he also originated the center of gravity method for loads on electric circuits. In illumination, he developed a diagram, known by his name, for determining the mean spherical candlepower of a lamp from its zonal distribution curve without the use of a planimeter.

In March, 1902, Dr. Kennelly advanced the theory that the conducting properties of the ionized rarefied upper atmosphere might reflect back electromagnetic waves, and later in the same year Heaviside also offered the same theory. This theory has been verified experimentally, and the reflecting upper atmosphere has become known as the Kennelly-Heaviside layer. In 1912, he worked out jointly with Dr. G. W. Pierce the motional impedance circle for a telephone receiver. This discovery is highly important, as it gives a method for evaluating the performance of a telephone receiver and the method is applicable to other vibrating apparatus having an electromechanical system.

Dr. Kennelly has published some twenty-eight books of which he is the sole author of ten. Among these are "Wireless Telegraphy and Telephony," "The Application of Hyperbolic Functions to Electrical Engineering Problems," "Chart Atlas of Complex Hyperbolic and Circular Functions," "Electrical Vibration Instruments," "Electric Lines and Nets." In addition he was the author of over three hundred and fifty technical publications.

Realizing the many advantages of the international metric system, as past president of the American Metric Society and after 1915 as officer of the Metric Association, he worked arduously to effect the adoption of the system in the United States; as a result it has already been adopted in many industries and laboratories, and has come to be used in athletic events.

He was always deeply interested in electrical units and standards. He was secretary of the Standards Committee of the American Institute of Electrical Engineers at its inception, and later became the chairman; likewise, at its inception in 1908, he was secretary of the U. S. National Committee of the International Electrotechnical Commission (I.E.C.), at one time was president and in 1938 was made honorary president. The I.E.C. always was one of his deepest interests and most continuous activities. In 1932 he was United States delegate and "chef de délégation" from the United States to the Paris Congress. On several occasions he was a delegate to international conferences on electrical units and standards and he assisted materially in the devising of the Meter-Kilogram-Second (MKS) system of electrical units which has recently been adopted internationally. At one time he was also chairman of the Sectional Committee of Definitions of the American Standards Association. For a number of years he was a member of the National Research Council, to whose work he made many valuable contributions.

He was deeply devoted to electrical engineering and its allied subjects and worked indefatigably for their advancement. To him this was not only a vocation, but in a large measure it was his recreation as well. His extensive contributions were made possible only by long hours of work and by planning and using his time with a high degree of efficiency.

The many who knew Dr. Kennelly were impressed by his versatility and resourcefulness and his breadth of interests. For example, in 1929 he presented a paper, "Meteorological Units Adopted by Various Countries." Also he has shown (1929) that an approximate law of fatigue underlies all the world's

tracing animals (and human beings) such that all the series of events plot as substantially parallel straight lines on logarithm paper. The writer has heard him give a lecture on Macaulay, the historian, that would do credit to an arts professor. He was also a natural linguist and could converse fluently in French, German and Italian.

He was an excellent teacher as well as investigator and scientist. He not only had a clear conception of the intricate relations that often exist in electrical circuits, but he was able to present them in direct and simplified form that is characteristic of the good teacher. He was held in the highest esteem by students and colleagues alike, and at all times was most congenial and courteous. The hospitality of Dr. and Mrs. Kennelly to students and the younger members of the instructing staff was long a tradition at Harvard.

Nothing was more delightful than an informal conversation with him, for he had a wealth of the most interesting experiences from which to draw, and the quiet humor that was always innate in him would inevitably come to the surface. He was a most interesting and resourceful speaker and his services as such were always in great demand, both in the United States and abroad.

When he retired as professor emeritus in 1930 his eyesight had begun to fail, and although operations served to prolong it, during the last year or two of his life he could barely distinguish even large objects. However, in spite of this and of rapidly failing health, he pluckily refused to give up the work to which his life had been devoted. Assisted by a chauffeur, he went regularly to his office each morning, and with the assistance of a secretary attended the considerable correspondence and other matters that came to him. Current technical literature, frequently in foreign languages, was read to him. At times a graduate student in electrical engineering assisted him in interpreting and making drawings, which he was unable to do himself because of his eyesight. It was under such difficulties that he wrote several recent papers dealing largely with electrical units and systems, particularly the MKS system. He continued thus to carry on until stricken down in his last illness. With the passing of Dr. Kennelly the world has lost a great scientist, teacher, scholar and gentleman.

Chester L. Dawes

SCIENTIFIC EVENTS

PUBLIC HEALTH IN GERMANY IN 1938

The Berlin correspondent of the *Journal* of the American Medical Association states that the report of the Public Health Service contains information regarding public welfare. Of those intending to marry, 47 per cent. made use of public consultations (36 per cent. in 1937). Of these, 38 per cent. received a marital loan, that is to say an addition to the expenses incidental to getting established. Maternity advice was sought by 6 per cent. of pregnant women. Infant welfare stations were available to the public in the ratio of one for seventy-seven infants born and were actually consulted on the average by sixty mothers per station. Consultation for pre-school children was offered in the proportion of 718 per hundred thousand inhabitants. More than 3,000,000 children of school age received attention, that is, about 4,545 per hundred thousand inhabitants. The schools of almost all districts, with few exceptions, were furnished dental supervision.

The care of tuberculous patients was extended during 1938. About 1,500,000 patients, against 1,250,000 in 1937, received attention. The number of roentgen treatments rose from about 1,250,000 to about 1,750,000. Hospitalization in public institutions increased from 45,000 to 49,000. Average x-ray examinations were 100 to thirteen patients. Somewhat greater facilities were provided for the treatment of venereal diseases, but the number of individual cases decreased (192,000 in 1938 against 200,000 in 1937). Consultation stations for cripples were increased and, on the average, 242 persons were advised per hundred thousand inhabitants. The increase in stations for alcoholic persons is more than counterbalanced by the decrease of the individual's consulting. However, other agencies not identical with these cooperated in the care for alcoholic patients, and their reports are not included in these figures. About 107,000 persons with psychic troubles were advised against 91,000 in 1937. The care for the infirm and aged is likewise organized according to regions. It is pointed out that these facts should not be regarded as completely evaluating the achievements of public health welfare in Germany, because there are other agencies besides the official health stations connected with public health bureaus.

THE HALL OF MAN AT THE WORLD'S FAIR

The American Museum of Health, which has offices at 30 Rockefeller Plaza, New York City, and a series of exhibits at the World's Fair, will have, according to *Museum News*, the cooperation of Mayor La Guardia in the endeavor to acquire a permanent building for the museum at the close of the fair. At the dedication ceremonies of the museum on the Theme Plaza of the fair on June 17 the mayor announced that he had in mind to assign for this purpose the court house building now occupied by the Appellate

Division, at Madison Avenue and 25th Street. This plan would depend on the working out of a project to build a new court house.

The museum has created or acquired the exhibits in the Hall of Man in the Medicine and Public Health Building of the fair. It includes in its installation the Oberlaender Trust exhibits portraying all the functions of the human body associated with walking, breathing, digestion, the senses and reproduction, many of them visitor-participation exhibits. The seven sections of the hall deal with walking and working, blood and air, eating and drinking, the skin, the five senses, demography (study of statistics of births, marriages, deaths, etc.), and the retreat of death. A model of a man 20 feet tall with blood-red heart, the beat of which can be heard throughout the hall, dominates the entire scene. This hall is a gateway to the Hall of Medical Science, which has exhibits illustrating up-to-date information on diseases and their treatment, also on social hygiene, public health administration and allied subjects sponsored by public health and philanthropic organizations. *Museum News* reports that these exhibits have been among the most popular at the fair.

The Carnegie Corporation of New York, the Rockefeller Foundation and the Oberlaender Trust have contributed to the support of the museum.

MEAD JOHNSON AND COMPANY "B-COMPLEX" AWARD

Nominations are solicited for the 1940 award of $1,000 established by Mead Johnson and Company to promote researches dealing with the "B-complex" vitamins. The recipient of this award will be chosen by a Committee of Judges of the American Institute of Nutrition, and the formal presentation will be made at the annual meeting of the institute at New Orleans on March 13, 1940.

The award will be given to the laboratory (nonclinical) or clinical research worker in the United States or Canada who, in the opinion of the judges, has published during the previous calendar year January 1 to December 31 the most meritorious scientific report dealing with the field of the "B-complex" vitamins. While the award will be given primarily for publication of specific papers, the judges are given considerable latitude in the exercise of their function. If in their judgment circumstances and justice so dictate, it may be recommended that the prize be divided between two or more parties. It may also be recommended that the award be made to a worker for valuable contributions over an extended period but not necessarily representative of a given year. Membership in the American Institute of Nutrition is not a requisite of eligibility for the award.

To be considered by the Committee of Judges, nominations for this award for work published in 1939 must be in the hands of the secretary by January 1940. The nominations should be accompanied by such data relative to the nominee and his research as will facilitate the task of the Committee of Judges in its consideration of the nomination.

L. A. Maynard,
Secretary of the American Institute of Nutrition
Cornell University,
Ithaca, N. Y.

RECENT APPOINTMENTS AT COLUMBIA UNIVERSITY

Twenty appointments to professorships have been made by the trustees of Columbia University. The appointments of four visiting lecturers and the promotion of two faculty members are also announced. Three of the new faculty members are clinical professors, five are assistant clinical professors, two are associate professors, and eight are visiting professors. Appointments in science and medicine include:

Dr. Joseph E. Mayer, associate professor of chemistry at the Johns Hopkins University, associate professor of chemistry.

Dr. Stephen P. Burke, director of the Industrial Science Division of West Virginia University, visiting professor of chemical engineering.

Dr. Tracy J. Putnam, professor of neurology at the Harvard Medical School and neurologist-in-chief of the Boston City Hospital, professor of neurology and neurosurgery.

Dr. Vernon W. Lippard, director of the Commission for Study of Crippled Children of the City of New York, assistant dean of the College of Physicians and Surgeons.

School of Medicine

Dr. Gregory Shwartzman, bacteriologist to the Mount Sinai Hospital, New York City, clinical professor of bacteriology.

Dr. Max Pinner, chief, Division of Pulmonary Diseases, Montefiore Hospital, New York City, clinical professor of medicine.

Dr. Kaufman Schlivek, ophthalmic surgeon to the Mount Sinai Hospital, clinical professor of ophthalmology.

Dr. Paul F. A. Hoefer, assistant in neurology, Harvard Medical School, and junior visiting neurologist, Boston City Hospital, associate professor in neurology.

Dr. John L. Nickerson, professor of physics, Mt. Allison University, Sackville, N. B., Canada, assistant professor of physiology.

Dr. James W. White, director of the service of ophthalmology, New York Post-Graduate Hospital and Dispensary, promoted from associate clinical professor to professor of clinical ophthalmology and executive officer of the department of ophthalmology.

Dr. George Anopol, chief of clinic and attending orthopedic surgeon in the dispensary, New York Post-Graduate Hospital, promoted from associate clinical professor to clinical professor of orthopedic surgery.

Dr. Erik J. Kraus, formerly professor of pathology and ector of the Institute, University of Prague, visiting fessor of pathology.

School of Tropical Medicine

Dr. John Scott Andrews, assistant zoologist, U. S. Dertment of Agriculture, at the Puerto Rico Agricultural periment Station, assistant professor of parasitology.

Dr. Esteban G. Cabrera, director, San José Hospital, nturce, Puerto Rico, and attending syphilologist of the iversity Hospital, associate professor of urology.

Dr. David B. Dill, professor of industrial physiology at rvard University, visiting professor of physiology.

Dr. William B. Porter, chief of medical service, Hospital vision of the Medical College of Virginia, visiting prossor of medicine.

Dr. William H. Taliaferro, dean of the division of the ological sciences in the University of Chicago, visiting ofessor of parasitology.

CHANGES AND NEW APPOINTMENTS AT HARVARD UNIVERSITY

The Harvard Alumni Bulletin gives the following ccount of changes in the scientific departments of the iversity.

Dr. Richard de Mises, formerly professor of applied echanics at the University of Berlin, has been apointed lecturer on applied mechanics and will give struction in the new course on aeronautical engineerg which the Graduate School offers this year. Proessor William C. Graustein, of the department of athematics, has been appointed assistant dean of the aculty of Arts and Sciences.

The *Bulletin* points out that the European war will eact on the academic program for the current year, nd its full effects may not be known for some time. Dr. George D. Birkhoff, professor of mathematics and ecently dean of the Faculty of Arts and Sciences, was ppointed Harvard exchange professor to France, and Dr. Albert Pauphilet was appointed French exchange professor at Harvard University, but it is not certain hat this exchange will take place. Holders of foreign fellowships and scholarships have been recalled r kept in this country, and foreign students who ntended to go to Harvard University this year are ot expected.

It is stated that at the time of going to press of the *Bulletin* there was doubt that Dr. Reginald P. Linstead, of the University of Sheffield, England, who late last year was appointed professor of chemistry, would be able to take up his work.

Visiting lecturers to the university from American institutions include Victor A. Conrad, of the Pennsylvania State College; Kurt Lewin, professor of child psychology at the State University of Iowa; Leslie Spier, associate professor of anthropology at Yale University; Hurd C. Willett, associate professor of meteorology at the Massachusetts Institute of Technology; and George de Santillana, of the New School for Social Research, New York City.

THE SEMI-CENTENNIAL CELEBRATION OF THE FOUNDING OF THE MEDICAL SCHOOL OF THE UNIVERSITY OF MINNESOTA

THE fiftieth anniversary of the Medical School of the University of Minnesota will be celebrated on October 12, 13 and 14. Addresses and papers to be presented will be concerned with trends in medical progress, with particular reference to chemistry in medicine. According to the program those participating in the exercises will be:

October 12

Morning Session, 9:00 o'clock. "Progress in the Application of Physical Chemistry to Medicine." George E. Fahr, professor of medicine, University of Minnesota, *chairman.* Speakers: Herbert M. Freundlich, distinguished service professor of colloid chemistry, University of Minnesota; Maurice B. Visscher, professor of physiology, University of Minnesota; John P. Peters, professor of medicine, Yale University; Thomas Parran, Jr., Surgeon-General, U. S. Public Health Service.

Round-table Discussion, 12:30 o'clock. Chairman, Ancel Keys, professor of physiology; Hal Downey, professor of anatomy; Elexious T. Bell, professor of pathology; Gaylord W. Anderson, professor of preventive medicine and public health, all of the University of Minnesota.

Afternoon Session, 2:30 o'clock. "Some Recent Investigations in Metabolism." Clarence M. Jackson, professor of anatomy, University of Minnesota, *chairman.* Speakers: Lee I. Smith, professor of organic chemistry, and George O. Burr, professor of physiological chemistry, University of Minnesota; George H. Whipple, professor of pathology and dean of the School of Medicine and Dentistry, University of Rochester; Charles H. Best, professor of physiology, University of Toronto.

Evening Session, 8:00 o'clock. Medical Education. Harold S. Diehl, dean of the medical sciences, University of Minnesota, *chairman.* Speakers: The Honorable Harold E. Stassen, Governor of the State of Minnesota; Guy Stanton Ford, president, University of Minnesota; Anton J. Carlson, distinguished service professor of physiology, University of Chicago.

October 13

Morning Session, 9:00 o'clock. "Some Aspects of Immunity and Chemotherapy." Winford P. Larson, professor of bacteriology, University of Minnesota, *chairman.* Speakers: Robert G. Green, professor of bacteriology, University of Minnesota; Perrin H. Long, associate professor of medicine, the Johns Hopkins University; Henry F. Helmholz, professor of pediatrics, the Mayo Foundation, University of Minnesota.

Round-table Discussions, 12:00 noon. Chairmen: Arthur D. Hirschfelder, professor of pharmacology; Frank C. Mann, professor of experimental medicine (the Mayo Foundation); Owen H. Wangensteen, professor of surgery; J. Charnley McKinley, professor of nervous and

mental diseases; A. T. Henrici, professor of bacteriology, all of the University of Minnesota. Leaders of the discussions will be Perrin H. Long, associate professor of medicine, the Johns Hopkins University; Walter B. Cannon, professor of physiology, Harvard University; Anton J. Carlson, distinguished service professor of physiology, University of Chicago; Detlev W. Bronk, professor and director, Institute of Neurology, University of Pennsylvania; Michael Heidelberger, professor of biochemistry, Columbia University.

Afternoon Session, 2:00 o'clock. "Some Approaches to the Nervous Control of the Organism." Andrew T. Rasmussen, professor of neuro-anatomy, University of Minnesota, *chairman*. Speakers: Irvine McQuarrie, professor of pediatrics, University of Minnesota; Herbert S. Gasser, director, Rockefeller Institute for Medical Research; Detlev W. Bronk, professor and director, Institute of Neurology, University of Pennsylvania; Walter B. Cannon, professor of physiology, Harvard University.

Evening Session, 6:30 o'clock. Harold S. Diehl, dean of the medical sciences, University of Minnesota, *chairman*. Speakers: Harold S. Diehl, dean of the medical sciences, University of Minnesota; Olaf J. Hagen, class of 1906, Moorhead, Minn.; Donald C. Balfour, director, the Mayo Foundation, University of Minnesota; Dr. George Earl, president of the Minnesota State Medical Association; Richard E. Scammon, distinguished service professor, University of Minnesota.

October 14

Morning Session, 9:00 o'clock. "Anniversary Clinics." William A. O'Brien, director, Postgraduate Medical Education, University of Minnesota, *chairman*. Speakers: Alfred W. Adson, professor of neurosurgery (the Mayo Foundation); Owen H. Wangensteen, professor of surgery; Arlie R. Barnes, professor of medicine (the Mayo Foundation); John L. McKelvey, professor of obstetrics and gynecology; Albert M. Snell, associate professor of medicine (the Mayo Foundation); Cecil J. Watson, associate professor of medicine, all of the University of Minnesota.

SCIENTIFIC NOTES AND NEWS

DR. CHARLES F. SCOTT, professor emeritus of electrical engineering at Yale University, recently celebrated his seventy-fifth birthday. The celebration occurred at New Haven, Conn., under the sponsorship of the Connecticut section of the American Institute of Electrical Engineers. Dr. Scott graduated from the Ohio State University in 1885, and has recently completed a two-year term as president of the national alumni organization. He is the son of the late Dr. William Henry Scott, one-time president of both Ohio and Ohio State Universities.

DR. BRONISLAW MALINOWSKI, professor of anthropology in the University of London and chairman of the Board of Studies, has been appointed visiting professor of anthropology at Yale University for the current college year. Dr. Harold St. John, head of the department of botany at the University of Hawaii, is Bishop Museum visiting professor.

IN the Cornell University Medical College in New York City, Dr. William H. Chambers has been promoted to the rank of associate professor of physiology and Dr. Kendrick Hare to that of assistant professor of physiology. As has been announced in SCIENCE, Dr. Joseph C. Hinsey, who has served as professor of physiology and head of the department since 1936, will succeed the late Dr. Charles R. Stockard as professor of anatomy and head of that department. During the present academic year he will also serve as acting head of the department of physiology.

DR. ALBERT B. SABIN, formerly associate of the Rockefeller Institute for Medical Research, has taken up his new work as associate professor of pediatrics at the University of Cincinnati and as fellow of the Children's Hospital Research Foundation. He will continue his studies on viruses and the filtrable micro-organisms of the pleuropneumonia group. One of Dr. Sabin's assistants will be Dr. Joel Warren, of the department of bacteriology of Columbia University, who will be a research associate in the Children's Hospital Research Foundation. Dr. Sabin will receive the Theobald Smith Award of the American Association for the Advancement of Science at its annual winter meeting.

DR. W. H. RIDDELL, associate professor of dairy husbandry and dairy products at Kansas State College, has become head of the department of dairy husbandry at the University of Arizona and at the Experiment Station.

FRANK COLLINS BAKER, since 1918 curator of the Natural History Museum of the University of Illinois, retired on September 1. He plans to devote his time to research. Dr. Leverett Allen Adams has been appointed his successor as curator of the museum and has been promoted to a professorship of zoology.

DR. CHARLES A. STONEBURG, formerly assistant in biochemistry and pharmacology in the Medical School of the University of Rochester, has been appointed instructor in pharmacology at the Medical College of the State of South Carolina to succeed Dr. S. Carl Werch, who has resigned.

DR. LEONARD WING has been appointed assistant professor of game management at the State College of Washington, Pullman. He will be in charge of the wildlife conservation work in the college. This work has been offered at the college since 1927 on a cultural basis. It has been expanded so that in recent

years a full four-year professional curriculum in wildlife conservation has been given.

Dr. Konstantin V. Pestrecov, who for the past two years has been working in the nuclear research laboratory of Columbia University, has been appointed research associate to Dr. Peter V. Karpovich at Springfield College, Massachusetts.

Dr. Horace C. Bold is a visiting lecturer this year in the department of botany of Barnard College, Columbia University. He will carry on the work of Professor Tracy E. Hazen, who retired last summer after thirty-six years of teaching at the college.

Dr. Harry M. Hines, professor of physiology in the School of Medicine of the University of Iowa, is on leave during the academic year of 1939–40. He is spending the year in the Cornell University Medical College, New York City, where he has been appointed research associate in physiology for the year of 1939–40. Dr. Jane Snow likewise has an appointment as research associate in physiology. Dr. Hines and Dr. Snow are cooperating in investigations which are being made possible by the interest of Dr. John Staige Davis, Jr., of New York City.

The Rockefeller Foundation has made a grant of $5,000 in support of the work of Dr. Paul L. Kirk, associate professor of biochemistry in the University of California at Berkeley, for his work in microchemical analysis and its application to biological problems.

The Committee on Scientific Research of the American Medical Association has made a grant to Dr. Owen H. Wangensteen, professor and head of the department of surgery at the University of Minnesota Hospitals, for a study of the physiologic rationale of operations performed for the relief of duodenal and gastric ulcer.

Dr. Robert P. Fischelis, executive secretary and chief chemist of the Board of Pharmacy of the State of New Jersey, has been appointed a member of the New Jersey State Board of Health. The appointment comes at a time when a new State Food, Drug and Cosmetic Act, similar to the Federal Food, Drug and Cosmetic Act, goes into effect in New Jersey. Because of the more complete control over the manufacture and distribution of drugs, devices and cosmetics provided in the new state law, the legislature amended the State Health Act to add a pharmacist to the Board of Health, and Dr. Fischelis is the first pharmacist to hold this appointment, which is for a four-year term under the amended act.

Dr. Robert D. Coghill, assistant professor of chemistry at Yale University, has been appointed chief of the Fermentation Division of the Northern Regional Research Laboratory, Peoria, Ill. He will direct research involving the utilization of bacteria, yeasts and molds as agents for converting wheat, corn and agricultural waste products into chemicals such as alcohols, glycerol acetic and other acids, acetone and other products which may be of industrial or agricultural interest.

P. Burke Jacobs has been appointed senior chemical engineer in the Agricultural Motor Fuels Division of the Northern Regional Research Laboratory, Peoria, Ill. He will be responsible for that part of the work of the division dealing with the production of industrial alcohol from agricultural materials grown or produced in the United States.

Museum News states that Dr. Walter B. Jones, director of the Alabama Museum of Natural History, has been appointed director of the newly established State Department of Conservation, and W. G. Lunsford chief of the Division of State Parks, Monuments and Historical Sites.

Dr. Carl E. Guthe, lecturer in anthropology, chairman of the Division of Social Sciences and director of the University Museums at the University of Michigan, has been elected a member of the Board of Trustees of the Cranbrook Institute of Science, Bloomfield Hills, Mich.

Dr. Horace W. Stunkard, professor of biology at New York University, has returned after a year's leave of absence, most of which was spent in the Institut für Schiffs- und Tropenkrankheiten at Hamburg, with short visits to Italy, France and England. He returned to attend the third International Congress of Microbiology held in New York on September 2 to 9, one section of which, protozoology and parasitology, had been organized by him.

Dr. Claude E. ZoBell has returned to the Scripps Institution of Oceanography after spending a year in studying research methods in water biology, during which time he was research associate in limnology at the University of Wisconsin for two semesters and fellow at the Woods Hole Oceanographic Institution for two months.

Professor Enrico Fermi, of the department of physics of Columbia University, will address a meeting of the New York Branch of the American Chemical Society on October 6 on "Atomic Disintegrations Produced by Neutrons."

Dr. Harald U. Sverdrup, director of the Scripps Institution of Oceanography at La Jolla, will give on October 9 one of the annual series of faculty lectures of the University of California at Los Angeles. His subject will be "The Sea off the Coast of California and Its Influence on our Climate."

Dr. C. B. van Niel, professor of bacteriology at

Stanford University, spoke at the Iowa State College on September 28 on "Bacterial Photosynthesis."

THE Hepsa Ely Silliman Lectures will be given at Yale University, beginning on December 4, by Dr. Richard Goldschmidt, professor of zoology at the University of California. The subject of the lectures will be "The Material Basis of Evolution." There will be eight lectures as follows: December 4, "The Neo-Darwinian Conception and its Taxonomic and Genetic Background"; December 5, "Microevolution within the Species"; December 7, "Are Subspecies Incipient Species?"; December 8, "The Species"; December 11, "Macroevolution by Large Steps"; and December 12, 14 and 15, "Evolution and the Potentialities of Development, I."

THE Conference on Methods in Philosophy and the Sciences, in celebration of the eightieth birthday of Professor John Dewey, has arranged a symposium on his contributions to method in the philosophy of the arts and sciences, which will be followed by a discussion. This meeting will be held at the New School for Social Research, 66 West 12th Street, New York City, on October 22, at 1:30 P.M. The program is as follows: Professor Arthur E. Murphy, University of Illinois, "Dewey's Work in Philosophy and Logic"; Dr. Hu Shih, Chinese Ambassador to the United States, "Some Further Aspects of Dewey's Philosophy"; Dr. Albert Barnes, the Barnes Foundation, "Dewey's Esthetics," and Professor Walton Hamilton, Yale Law School, "Dewey and the Social Sciences."

THE 1939 convention of the Association of Land-Grant Colleges and Universities will meet on November 15, 16 and 17 at the Willard Hotel, Washington, D. C.

THE annual meeting of the Carolina Geological Society will be held at Spruce Pine, N. C., on October 21 and 22, under the presidency of Professor L. L. Smith, of the University of South Carolina. J. H. Watkins, the Citadel, Charleston, S. C., is vice-president, and Professor Willard Berry, of Duke University, is secretary-treasurer. The pegmatites and associate mineral deposits of that area will be visited under the direction of B. C. Burgess, of the Tennessee Mineral Products Corporation of Spruce Pine.

A SYMPOSIUM on Temperature, its Measurement and Control in Science and Industry will be held in New York City at the Pennsylvania Hotel, on November 2 to 4, by the American Institute of Physics, with the cooperation of the National Bureau of Standards, the National Research Council and officers and committees of many technical societies. The program is in charge of representative committees of authorities in various fields, who have arranged for a program of a hundred or more papers on scientific and technical subjects, which will be presented in concurrent sessions of selected groups. All those active in science or engineering are cordially invited to attend the sessions and to take part in the discussions of papers. A complete program containing full abstracts of the papers to be presented will be mailed in advance on request to the institute. It is suggested that those who expect to attend will inform the institute and make their hotel reservations early. There will be a registration fee of $1.00. The chairmen of the committees are Gustav Egloff, A. W. Ewell, C. O. Fairchild, J. D. Hardy, H. F. Mullikin, F. H. Norton, R. B. Sosman, C. B. Veal, H. T. Wensel and G. B. Wilkes. H. A. Barton, director of the institute, is chairman of the main committee.

ACCORDING to the *British Medical Journal* delegates from all parts of Scotland are being invited to attend a conference, dealing with nutrition and education, which is to be held at the rooms of the British Medical Association in Edinburgh on Saturday, October 14, under the auspices of the Scottish Committee against Malnutrition. There will be an afternoon and evening session. Sir John Boyd Orr, director of the Rowett Research Institute, Aberdeen, will be one of the speakers. It is expected that about forty organizations will be represented at the conference. The afternoon session will be devoted to a discussion of "Existing Nutritional Conditions as Compared with Minimum Health Requirements." The evening session will deal with "Malnutrition as it Affects Education."

THE Council of the American Chemical Society has announced that "Alpha Chi Sigma having presented to the society a definite pledge to sponsor the Award in Pure Chemistry in 1940, and having pledged $1,000 therefor with the expectation that they would shortly be able to assume the obligation for a period of three years, it was moved, seconded and carried that their offer be accepted with thanks and appreciation, and that the regulations heretofore used be continued with the additional proviso that there should be no restrictions as to the 'status of employment of the candidates under consideration.'"

DISCUSSION

ATMOSPHERIC CONTAMINATION

THE purpose of this discussion is to present physical methods for evaluating the concentrations of certain gases and vapors when admixed with atmospheric air. These methods are limited to compounds such as CO_2, CO, CH_4, etc., which have characteristic absorption bands in the infrared. In view of the fact that some time must elapse before portable apparatus suitable

use in mines, tunnels, etc., shall have been devel-ed, it seemed advisable to present a preliminary ac-unt of the work. Due acknowledgements will be de in a later, more detailed, publication.

The principles involved may, perhaps, be set forth re clearly by considering CO_2 as the contaminating s. It is well known that CO_2 has narrow regions of ong absorption and emission near 2.7 and 4.4 μ in infrared. According to the first procedure tried, liations from a jet of hot CO_2 are passed through absorbing chamber and are focused on a thermopile. nce the radiations from hot CO_2 are largely absorbed ly by cold CO_2, it is evident that CO_2 in the absorb-g chamber would reduce the intensity of the radia-ns falling on the thermopile—other gases and pors in the chamber being ignored. The actual paratus is sketched in Fig. 1, where J is a small

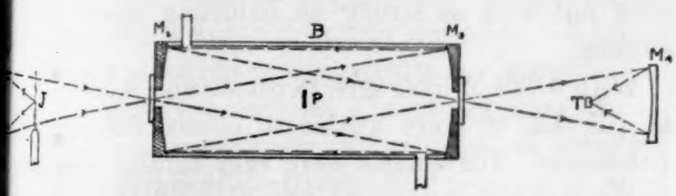

FIG. 1.

t of hot CO_2 whose radiations, after leaving the con-ve mirror M_1, are focused on the absorbing chamber This consists of a brass tube (30 cm long and 6 cm diameter) whose ends are closed by the concave irrors M_2 and M_3—each supplied with a central le 1 cm in diameter. As is evident, these mirrors ake it possible to send the radiation through the tube ree times. Direct transmission through the tube is evented by the introduction of a small baffle at P. e system is made gas-tight by waxing windows of orite or rock-salt over the holes in the mirrors. The irror M_4 focuses the emergent radiations on a ther-opile T, which is connected to a sensitive galva-ometer.

The results obtained are confined largely to CO_2. sing as source the radiations emitted by the hot CO_2 und in the non-luminous portion of a small gas-jet urning in a water-cooled jacket) it was found that s than one part of CO_2 in a million of air could be tected. By employing a jet of hot CO_2 as the urce, water-vapor in the absorbing chamber was com-etely ignored.

This procedure was soon found to suffer from a mber of serious defects such as (1) lack of con-ancy of the source, (2) inability to heat all gases d vapors to a sufficiently high temperature without inging about decomposition, (3) lack of exact agree-ent of the spectral regions of emission of the hot gas d of absorption of the cold gas.

Accordingly, a second procedure was evolved. Here, radiations from an incandescent nichrome spiral at J are passed through the absorbing chamber and are allowed to fall on a closed but (infrared) transparent receiver T filled with CO_2. As long as the absorbing chamber is free from CO_2, the gas in the receiver will be heated, due to the selective absorption of the radiations near 2.7 and 4.3 μ. If, however, some CO_2 be admitted to the absorbing chamber, this gas will absorb, prematurely, some of the radiations which, previously, had heated the receiver. As a result, the temperature of the latter will drop. The first of these selective receivers consists of a brass capsule whose ends are closed with plates of rock-salt. After filling with CO_2 through a suitable side tube, this is connected to an improvised stethoscope. By mounting a phonic wheel at M_2 and raising the rate of interruption to about 200 per sec. a fairly loud sound is heard by applying the stethoscope to the ears. Evidently the CO_2 in the receiver is periodically heated by the direct absorption of radiant energy. Eventually this sound is to be amplified so that, upon replacing the loud-speaker by a portable galvanometer, sound-intensity may be translated into galvanometer deflections.

A second and more immediately useful receiver was constructed on the idea that if a polished thermopile were introduced into an infrared-transparent receiver filled with CO_2 and if the thermopile junctions were shielded from direct radiation, then the adjacent CO_2 would be heated by radiation and would, by diffusion, heat the junctions of the thermopile.

This receiver showed high sensitivity as well as selectivity. Having filled the receiver with CO_2, ordinary illuminating gas, free of CO_2, was allowed to fill the absorbing chamber to atmospheric pressure. In spite of the fact that illuminating gas contains methane and carbon monoxide, both to the extent of 20 per cent. or more, no measurable absorption could be detected. When, on the other hand, the receiver was filled with CO_2-free illuminating gas, the effect was enormous.

Obviously, the highest degree of selectivity is achieved by using as source a jet of hot gas or vapor x whose radiations fall on a selective receiver filled with x; the presence of x between source and receiver will be recognized decisively.

A. H. PFUND

JOHNS HOPKINS UNIVERSITY

OXIDATION-REDUCTION POTENTIALS AND THE MODE OF ACTION OF SULFANILAMIDE

THE report by Shaffer[1] concerning a possible relationship between the potentials developed by certain

[1] SCIENCE, 89, 547–50, June 16, 1939, and Cold Spring Harbor Symposia on Quantitative Biology, 7, 1939, to be published.

oxidation products of sulfanilamide and its therapeutic activity contains much that is suggestive. Certainly it is reasonable to suppose that some oxidation of sulfanilamide occurs in the body. Furthermore, it is possible that the oxidation products account for the therapeutic effect. But that the high potentials reported by Shaffer are due to oxidation products of sulfanilamide and are responsible for the activity of the drug is open to question.

We believe that these apparently abnormally high potentials are attributable not to any oxidation products of sulfanilamide, but to the oxidizing agents used. For example, if to a dilute solution of sulfanilamide a dilute solution of ceric sulfate is added gradually as in a titration, some cerous sulfate will be formed almost immediately. As a result, a potential due to the cerous-ceric system will be established. Eventually all the ceric sulfate from any one addition will be reduced by the sulfanilamide. The reaction would be very slow in dilute solutions, however, and, if fresh additions of ceric sulfate were made before all the previous portion was reduced, a fairly steady potential would result. This should be particularly true if the rate of addition of ceric sulfate approximated its rate of reduction. Since the E_0 of the cerous-ceric system is -1.46 volts,[2] it would not be surprising to find high potentials. Most of the other effective oxidizing agents mentioned by Shaffer show potentials of the same order of magnitude.

The method used in our experiments was briefly as follows:

A standard Beckman Model G pH meter was used to record oxidation-reduction potentials. The cell was equipped with a saturated calomel half-cell, gold and platinum electrodes, a mechanical agitator, nitrogen inlet tube and 50 cc burette. Before, and at intervals during the course of the work, this set-up was checked with quinhydrone at various pH values. The results in all cases checked to within the limits of the instrument (± 3 millivolts).

A typical experiment involved the titration of 100 cc of 0.001 M sulfanilamide dissolved in 1.0 N sulfuric acid (pH 0.8) with 0.001 M ceric sulfate in 1.0 N sulfuric acid. By plotting observed potentials against cc of ceric sulfate added, curves were obtained which showed the same "plateau potentials" reported by Shaffer. If, however, the rate of addition of ceric sulfate was varied, differences in the "plateau potential" of as much as 70 millivolts were obtained. The same drift in potentials was also observed. This could be demonstrated more strikingly when 0.01 M ceric sulfate was employed. No "plateau potential" was obtained in this case, the potentials falling very rapidly to a limiting value.

It was possible to plot potentials against the time following the addition of a given amount of 0.01 M ceric sulfate. Smooth curves were obtained which appeared to be a direct indication of the rate of oxidation of sulfanilamide. With some refinements, it is possible that this method might be applied to a quantitative study of the rate of oxidation of aromatic amines. Preliminary studies on several compounds including sulfapyridine, p,p′-diamino diphenyl sulfone and o- and m-amino benzene sulfonamide were made by means of this technique. This work was carried out with the idea that rate or ease of oxidation might be a factor in chemotherapeutic activity. However, no significant difference in the rate of oxidation of the above compounds could be demonstrated by this method, at least not with as strong an oxidizing agent as ceric sulfate.

With 0.008 M hydrogen peroxide and 0.0001 M Fe at pH 4.6 we were unable to obtain the same high potentials. The results were very erratic and seemed to depend largely on the condition of the electrode. Potassium permanganate gave much the same results as ceric sulfate except that no definite end-point could be established. For the results on potassium permanganate we are indebted to Dr. A. Moos, of the Lederle Laboratories, Inc., Pearl River, N. Y.

It might be argued that the rapid drop in potential when higher concentrations of ceric sulfate were employed was due to the rapid disappearance of the intermediate oxidation products of sulfanilamide responsible for the potentials. However, when a reverse titration was carried out, by adding 5- or 10-cc portions of 0.001 M sulfanilamide to 100 cc of 0.002 M ceric sulfate, the potentials at equilibrium were in good agreement with those calculated for a cerous-ceric system on the basis of four equivalents of ceric sulfate to one of sulfanilamide. The number of equivalents was determined by the normal titration method as described by Shaffer and was close to four.

Finally, we found that, on standing for 48 hours, a solution of 100 cc of 0.001 M sulfanilamide in 1.0 N sulfuric acid, to which was added 15 cc of 0.01 M ceric sulfate, developed a single electrode potential which was close to -0.6 volt. Since the gold and platinum electrodes checked as usual, we have assumed that this was a true equilibrium potential. The value obtained in this way was of the same order of magnitude as the potential reported by Conant and Lutz[3] for the system phenyl hydroxylamine-nitrosobenzene. We have determined this equilibrium potential for several therapeutically active and "inactive" compounds. Of th

[2] Kunz, *Jour. Am. Chem. Soc.*, 53: 101, 1931. The sign convention of Lewis and Randall, "Thermodynamics," McGraw-Hill Book Company, New York, N. Y., Chapter XXX, 1923, is used in this report.

[3] *Jour. Am. Chem. Soc.*, 43: 1059, 1923.

ive substances, the potentials of sulfanilamide, sulpyridine and p,p′-diamino diphenyl sulfone were asured. The potentials of these fell within a range 20 millivolts. o- and m-amino benzenesulfonamide re the "inactive" compounds examined. These two bstances gave potentials about 50 millivolts lower n the active compounds.

It must be emphasized that, until more is known out the blood levels obtained and the rate of absorpn and excretion of "inactive" compounds, it is not ssible to accept them as inactive in theoretical conerations. When an attempt is made to correlate tivity, only compounds known to be present in the od stream for intervals of time and in concentrans comparable with sulfanilamide or sulfapyridine, d under these conditions showing no therapeutic ect, should be considered as inactive. Strangely ough, for this type of work, some well-studied intive compounds would be highly desirable. It seems ssible that attempts of this sort to use some fundaental physical property as a stepping-stone in atking the problem of correlating chemical structure th chemotherapeutic activity may lead to a more tional basis for the selection of new chemotheraeutic agents. Further work of this general nature ll be reported later.

We conclude, on the basis of the following facts, t the "plateau potentials" of Shaffer are a function the oxidized and reduced forms of the oxidizing ents employed, rather than of the oxidation prodts of sulfanilamide:

(1) In the presence of excess sulfanilamide the tentials fall rapidly as the oxidized form of the idizing agent is exhausted.

(2) Equilibrium potentials are established if parlly oxidized solutions of sulfanilamide are allowed stand for 48 hours.

(3) When an excess of ceric sulfate is present, the uilibrium potentials agree with those calculated for cerous-ceric system.

(4) The "plateau potentials" can be varied within ide limits, depending on the rate of addition of the idizing agent.

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TRUCTURE AND SYNTHESIS OF A PLANT WOUND HORMONE

IN an earlier publication the isolation of a crystalne substance possessing wound hormone activity has en described.[1] This substance, which was isolated om the water extract of green string-beans, possesses the property of eliciting renewed growth activity in the parenchymatous cells of the bean mesocarp, and its activity may hence be quantitatively determined by the bean test which has been described elsewhere.[2] Elementary analysis of the crystalline product, together with its molecular weight (by m.p. depression in camphor) leads to the formula $C_{12}H_{20}O_4$, and the equivalent weight by titration indicates a dibasic acid.[1] Upon catalytic hydrogenation a crystalline dibasic acid, $C_{12}H_{22}O_4$, identical with decane-1,10-dicarboxylic acid was obtained. After oxidative degradation of the natural wound hormone, sebacic acid was obtained in good yield. The substance must therefore be 1-decene-1,10-dicarboxylic acid:

$$HOOC\cdot CH{=}CH\cdot CH_2\cdot CH_2\cdot CH_2\cdot CH_2\cdot CH_2\cdot CH_2\cdot CH_2\cdot CH_2\cdot COOH.$$

This structure has been confirmed by synthesis of 1-decene-1,10-dicarboxylic acid. The resulting product was found to be identical with the natural product both in chemical properties and in physiological activity.

1-decene-1,10-dicarboxylic acid is capable of evoking intensive wound periderm formation in washed discs of potato tuber. It would seem probable therefore that the material with which Haberlandt[3] dealt in his early investigations of wound hormone activity in the potato was at least in part 1-decene-1,10-dicarboxylic acid. It would seem appropriate and convenient to refer to this substance as "traumatic acid"[4] (from Greek τραῦμα = wound). A detailed report of these investigations will appear elsewhere.

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THE PLASMODIUM OF HEMITRICHIA VESPARIUM (BATSCH) MACBR

SCLEROTIUM collected from a partially decayed log furnished the source of material used in studying certain cytoplasmic elements in the plasmodium of a Mycetozoan species that had been treated with mitochondrial methods of technique.

When exposed to a humid condition in a large dish, the revived sclerotium issued a bright yellow stream of plasmodium on the woody substratum that had been thoroughly moistened. At this stage of development it was impossible to make an accurate determination of the species involved. For over four months the plasmodium was active under the stimulus of food, moisture and slight light, but when exposed to a bright,

[1] J. English, J. Bonner and A. J. Haagen-Smit, *Proc. at. Acad. Sci.*, 25: 323, 1939.

[2] J. Bonner and J. English, *Plant Physiol.*, 13: 331, 1938.

[3] G. Haberlandt, *Sitzungsb. d. Königl. Preus. Akad. d. Wiss.*, 16: 318, 1913.

[4] Report of work carried out with the aid of the Works Progress Administration, Official Project No. 665-07-3-83, Work Project Number 9809.

artificial light for a continued period, immediate fruiting resulted. On examining the fruiting bodies, it was possible to classify the species as *Hemitrichia vesparium*.

A survey of the taxonomic history of *Hemitrichia vesparium* discloses that the color assigned to the plasmodium has been purple-red with no reference to the conspicuous yellow color observed in this study. It is of interest to record this color observation, since the recent monographs of Lister (1925) and Martin and Macbride (1934) assign a shade of red or purple to the plasmodium, evidently in accordance with the descriptions of the earlier workers. Whether the early descriptions of the form are inadequate as to the color status of the plasmodium or whether the plasmodium under certain physiological conditions assumes a purple-red, while under others a bright yellow color, are interesting questions. However, it appears from previous observations that plasmodia in relation to species are distinctly constant in color aspect.

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UNIVERSITY OF VIRGINIA

LITERATURE SERVICE FOR CHEMISTS

BEGINNING on October 1 the Hooker Scientific Library, Fayette, Missouri, inaugurated a new literature service for chemists. Dr. Julian F. Smith is leaving the du Pont Company, where he has been doing chemical literature work, to become associate director of the "Friends of the Hooker Scientific Library," of which Dr. Neil E. Gordon is director.

Through Dr. Smith the library will offer translations and literature searches, backed by facilities for providing filmstat or photostat copies of any matter in the more than twenty thousand volumes comprising the collection. To his chemical education (B.S., Illinois 1916; M.S., California 1920; Ph.D., Chicago 1922) and his long experience in chemical literature work Dr. Smith adds linguistic skill acquired by years of practice in translating from German, French, Spanish, Italian, Portuguese, Dutch, Scandinavian, Polish and Russian.

The combination of a specialist in technical literature and one of the most comprehensive chemical libraries ever assembled is unique in chemical reference service. It offers an unprecedented opportunity to all chemists to have technical literature or patents clearly and accurately translated by a chemist, and to have the literature on any problem skilfully combed by an experienced searcher who is not hampered by language barriers.

The Hooker Scientific Library will render these services at cost (on a self-supporting but not a profit basis) to members of the "Friends of the Hooker Scientific Library." The minimum fee for an individual life membership is $10; for a permanent corporation or institutional membership, $100. All who are interested are invited to write to Dr. Neil E. Gordon, Central College, Fayette, Missouri.

NEIL E. GORDON

CENTRAL COLLEGE,
FAYETTE, MO.

SCIENTIFIC BOOKS

RECENT BOTANICAL BOOKS

Protein Metabolism in the Plant. By ALBERT C. CHIBNALL. xv + 306 pp. 21 figs. 9 plates. Yale University Press, New Haven. 1939. $4.00.

THE Silliman Memorial Lectures in Yale University for 1938 are here presented in an expanded form. It is fortunate that our knowledge of the physiological chemistry of the proteins in plants should be summarized for the benefit of plant physiologists and biochemists by one whose researches have led him far into the field. Drawing from his own extensive experience and from a wealth of historical and present-day literature, Professor Chibnall has succeeded in presenting a thought-provoking account of the problems and the progress of this field of plant science. The first three chapters are devoted almost entirely to a historical survey of many of the earlier contributions to the protein metabolism in seedlings from the point of view of their relationships to contemporary protein chemistry. Since they include commentaries upon the works of many of the original investigators of the natural amino acids, these chapters should be of additional interest to all present-day students of biochemistry. The classical studies of Pfeffer, Schulze and Prianischnikow receive special consideration and are interpreted in the light of more recent knowledge. One chapter discusses the formation of asparagine and glutamine in seedlings, with emphasis upon the origin of the ammonia and of the carbon precursors. Another deals with the mechanism of amino acid and protein synthesis in plants, and stresses the rôle of the α-keto acids. The preparation of proteins from leaf tissues and the application of the author's own methods to extensive studies of the composition and nutritive value of the proteins of forage plants are described at some length. Three chapters explore the protein metabolism of leaves and the rôle of proteins in the respiration of detached leaves. Evidence for the existence of a protein cycle in leaves is critically discussed, and the interrelationships between organic acids, carbohydrates and fats and proteins in leaf respiration are considered.

The contents of these three chapters are of particular importance in the sense that major developments in plant physiology seem to be here foreshadowed. The final chapter is concerned with the regulation of protein metabolism in leaves. The factors which determine when and to what extent proteins are synthesized and decomposed during the various stages of development of the plant are discussed in so far as present knowledge permits. Three appendices present valuable data on the hydrolysis and constituent analysis of leaf protein preparations.

The lectures represent the author's interpretations of a very large number of uncoordinated researches in an especially difficult field of investigation. Nevertheless, they present as a unit the most extensive and stimulating commentary yet available on the state of our knowledge of the metabolism of amino acids, amides and proteins in the green plant.

R. F. DAWSON

COLUMBIA UNIVERSITY

Elements of Plant Pathology. By IRVING E. MELHUS and GEORGE C. KENT. vii + 493 pp. 259 figs. The Macmillan Company, New York. 1939. $4.00.

THIS book is designed for an elementary course of one quarter or semester for students training for various aspects of agriculture. The authors have placed emphasis on phenomena of parasitism and principles of disease control and have condensed or omitted mycological and morphological considerations. Citations to literature are omitted, save for a list of books on or directly relating to plant pathology; and references to individual investigators are usually restricted to instances of classical contributions.

The first 113 pages deal with general aspects or principles, including chapters on plant pathology and human affairs, development of plant pathology, disease in plants, parasitism, the influence of environment on plant diseases and principles of control measures. The following 336 pages are devoted to specific parasitic diseases, grouped according to the systematic relations of the pathogens. Non-parasitic diseases are treated in 14 pages. A glossary of 7 pages follows.

The authors have made an excellent selection of material and presented it clearly and forcefully. The chapter on plant pathology and human affairs strikes at the outset a note of vitality that is maintained throughout the book. The reader with imagination is constantly reminded of the important contributions of plant pathology in the struggle of the race for an adequate physical basis to support its life and culture. The sharp restriction of the mycological, morphological and bibliographical treatment will be regarded by some as a disadvantage. Furthermore, the mode of treatment that the authors have chosen sometimes implies a finality that they would scarcely wish to maintain in a more advanced course. If these are disadvantages, they are largely imposed by the plan of treatment, which was thoughtfully developed by the authors in the light of their extensive teaching experience in both plant pathology and general botany.

The book is excellently printed and illustrated and will be welcomed as a valuable contribution to elementary teaching of plant pathology.

G. W. KEITT

UNIVERSITY OF WISCONSIN

The World of Plant Life. By CLARENCE J. HYLANDER. xxii + 722 pp. 249 figs. 195 plates. The Macmillan Company, New York. 1939. $7.50.

THE author has attempted a somewhat unusual work, a synoptical survey of the plant kingdom for popular consumption. The first 121 pages are devoted to an account of the groups usually included under the Thallophyta (here divided into 7 phyla), together with chapters on the Bryophytes and Pteridophytes. The bulk of the book consists of an enumeration of the larger families of flowering plants, arranged in an order which includes some rather puzzling departures from any current systems of classification. The plants dealt with include the more outstanding, curious, interesting and economically important forms, not only of the United States but of the world. Particular emphasis is laid upon food and ornamental plants, their origin and use. The magnitude of the work may be appreciated by the fact that the check list of species mentioned in the text includes nearly 2,000 scientific names. The numerous and on the whole excellent illustrations will aid materially in the recognition of many of these forms.

The author states that the book is planned primarily for the layman, and secondarily for college students who have had some introduction to the field of botany, for the semi-professionals such as gardeners and members of horticultural societies and for specialists in some small field of botany. Certain chapters should indeed appeal to the layman; among these is the introductory chapter, which deals with such topics as the nature of plants, a comparison of plants with animals, physiology, reproduction, classification, the significance of plant life to mankind, and the chapters on plant epiphytes, saprophytes and parasites, the orchids, the cacti, carnivorous plants and the beverage plants. While the book may appeal to one who has already had considerable experience and contact with plant life, and therefore constitutes a welcome addition to the shelves of plant-minded people, it is not, in the opinion of the reviewer, a book for the general reader. It is too bulky and too technical, and its encyclopedic account of the families of angiosperms belongs rather in a work of reference than in the type of book likely to be favored by one unacquainted with plant life.

Any attempt to popularize a subject is certain to bring forth criticisms of over-simplification from professional workers in the field. The book in general is not open to such criticisms, although it may be hoped that the term "breathing pores" as applied to stomates may eventually disappear even from popular literature. Here and there careless statements and minor errors occur, together with confusion and mislabeling in connection with the illustrations. Perhaps there are no more errors than might be expected in a volume of this size.

The author writes well, with many a happy turn of phrase, and demonstrates that he has mastered many of the aspects of presenting scientific subject-matter to the public, but his zeal and industry have caused him to fall short of his main purpose in this case.

C. L. WILSON

DARTMOUTH COLLEGE

ANNUAL REVIEW OF PHYSIOLOGY

Annual Review of Physiology. JAMES MURRAY LUCK, Editor. VICTOR E. HALL, associate editor. American Physiological Society and Annual Reviews, Inc., Stanford University P. O., California, 1939. Pp. 705. $5.00.

THE first volume of Annual Review of Physiology—a sister publication to the well-established Annual Review of Biochemistry—comes as a welcome addition to the field of scientific publications. It is the only attempt to present in the English language a survey of contemporaneous work in physiological sciences, and the only publication in any language which accomplishes the task well, in concise and inexpensive form. This, of course, is largely due to the enthusiastic and conscientious efforts of the various contributors, each an authority in the field covered.

It is impossible to give a synopsis of a volume such as this, but mention of a few items selected at random may be allowed. Needham's review of Developmental Physiology calls attention to the importance of bringing embryology into the physiological field. The development of form depends on metabolic changes, and further understanding of embryological changes will be more and more determined by a better understanding of the energetics of cell growth and differentiation and of the chemical and physical excitants concerned. Burton's review of Temperature Regulation is characterized by explicit emphasis on the most significant lines of advance, *e.g.*, the evidence dealing with the more exact localization of the heat-regulating center in the hypothalamus and the highly discriminating power of peripheral temperature receptors. The extensive work of Winton, DuBois, Burton and their associates on ultimate factors concerned in heat loss, and their relation to clinical fevers, climatic adaptation, air conditioning, etc., are all reviewed. Murlin, in a section devoted to Energy Metabolism, gathers together in an authoritative way much new work relating to such old subjects as normal standards of basal metabolism, the importance of racial and hormonal factors, etc.

Bazett reviews the Peripheral Circulation, devoting considerable space to the subject of aortic elasticity. The control of the peripheral circulation by nervous and local metabolites has received renewed attention during the year that has passed, but one wishes it were possible to sift the material more critically. Some overlapping of subject-matter, with a subsequent chapter by Eyster on Heart occurs, a difficulty that will perhaps always exist in the artificial subdivision assigned to reviewers. Eyster's review includes new work on the course of impulses in the heart, electrocardiography, vectorcardiograms, etc. Limitation of space has prevented the expansion of subjects that the reviewer would have liked to see.

Gesell offers a charming review of Respiration, but is too inclined to fit all work into his own mold of thought. Bozler gives a good review of Muscle, and Ivy and Gray of the Digestive System. Newer work seems to relieve the gastric sphincter somewhat of its age-long function of guarding the pyloric gate, and nerves seem to have a subsidiary responsibility for secretion of bile. The reviewers properly stress the difficulty of drawing conclusions from experiments in which nerves are sectioned or stimulated, for, in control of secretion and motility, separate fibers rather than whole nerve trunks are undoubtedly activated. Mann and Bollman edit the complementary chapter which surveys the multifold functions of the liver. Hope is renewed that the moot problem of the fatty liver may soon be completely solved as a result of the application of experimental methods. It emphasizes the need of doing something more than looking at tissues through a brass tube with pieces of glass at its ends.

The contributions that have been made by means of action potentials in our understanding of the activity of nerve, spinal cord and brain are authentically analyzed by Bronk and Brink, Jr., Eccles and H. Davis, respectively. Hinsey reviews the work on the autonomic nervous system in his usual conservative manner, giving particular attention to the importance of the afferent pathways. The new work on posterior root afferents is included.

Homer Smith reviews the newest developments in renal secretion and calls attention to the possible intrarenal regulating mechanism for the control of blood flow, to the possibility of extraglomerular blood supply to the tubules, and to the action of the posterior pituitary and adrenal cortex on renal function.

Applied physiology is reviewed by Dill. This is restricted to such fields as muscular exercise, high tem-

perature, low and high partial pressure of oxygen, etc. One wonders whether the term Applied Physiology should be allowed to be preempted for such a narrow field. The applications of physiology to medicine must not be forgotten and should form a topic for discussion in future reviews.

H. Evans gives his usual complete and lucid discussion of certain Endocrines—Gonads, Pituitary and Adrenals. In the great whirlpool of real and apparent contradictions, it is always refreshing to have Evans aid us in regaining another hold on the problems.

In conclusion, an ample index of authors and subjects covering 52 pages adds greatly to the value of the work as a reference medium. The sphere of usefulness of the Annual Review of Physiology should be large. A casual reading of any section—or of the whole volume for that matter—provides the reader with a good perspective of the trends that recent investigations are taking. The style is terse, crisp and pleasingly devoid of useless verbiage; but nevertheless reads like a connected narrative.

The reader who cares to delve deeper into particular problems is provided ample opportunity for doing so. The preface states that the aim is to furnish breadth rather than depth of information. But, correctly used, depth is there, too. Each section contains sufficient references to serve as leads for other work, past and present, so that the doubting reader need not necessarily accept the interpretations of contributors. However, the latter, on the whole, seems to be fair and impartial, but generally can not be regarded as overcritical. The question remains whether categorical statements of discoveries claimed or a little more separation of wheat from chaff is the more desirable form of review.

CARL J. WIGGERS

WESTERN RESERVE UNIVERSITY
MEDICAL SCHOOL

REPORTS

SCIENTISTS AND THE PRESS

A COMMITTEE of the Boston and Cambridge branch of the Association of Scientific Workers, consisting of five scientists and three journalists, has examined in some detail problems of science news reporting. The following statement has been prepared in the hope of stimulating consideration of this matter, and eliciting comment and criticism.

Arrangements for reporting scientific work in the press are at present largely haphazard. The selection of science news is left almost wholly to journalists, who obtain it from a variety of sources, competent and otherwise. In these circumstances science reporting is inevitably scattered, superficial and centered about prominent personalities. Frequently it has been grossly inaccurate, or so poorly designed as to be almost certainly misleading.

Yet many scientists believe that wider and more dependable distribution of scientific information should benefit both science and the public. It should help to educate a large body of laymen in scientific objectives and accomplishments. It should mobilize aid for research, by interesting individuals and industrial organizations and by enlisting popular support for the governmental maintenance of science projects. Widespread and accurate news reports should help to counteract the flood of pseudo-scientific commercial propaganda in our newspapers; and equally the pronouncements of a few individuals who are popularly supposed, not always justly, to speak for science as a whole. Science is but one of many social activities, and particularly in a democracy the public should be kept well informed of its methods and purposes. Such knowledge constitutes a strong defense both of the public and of the future of free scientific activity.

Occasional scientists, however, feel that science should be withheld from newspapers, that they distort it in fact and spirit. In this light the recipients of newspaper publicity are sometimes regarded with suspicion and disapproval. Yet this position grows increasingly weaker. If only because the scientist can not control newspaper accounts of his work, which often appear without his knowledge or cooperation, the stigma sometimes associated with publicity is unreasonable and dangerous.

This is perhaps the crux of the matter. Scientists can neither suppress nor restrict science news. Usually they do not initiate it. Yet they are held responsible for it by the public and by many fellow scientists. A policy of passive resistance in the past has helped only to produce a chaotic press which seriously injures science and the individual worker.

A positive alternative is for scientists to recognize in the press a valuable agency for liaison with the public, and to attempt through active cooperation to improve its effectiveness. Such an approach admittedly offers difficulties. Important steps toward their solution already exist in Science News Service, the American Chemical Society News Service and similar institutions created by scientists; and the press has cooperated to a degree by employing specialists in science news, such as those who form the Association of Science Writers. But such agencies can use only what they are given. The general problems of initiation and critical supervision of science news can be solved by scientists alone.

As a first experimental approach to this situation we are testing the following plan at certain of the Harvard University science departments.

At our suggestion each of these departments has appointed an informal representative to deal with press problems. These men aid in preparing news reports from their departments and act as clearing agents for press inquiries. About once every month they meet with representatives of the University News Office and Science Service to discuss common problems and anticipated news situations.

The usual spot news report is handled as follows. The departmental representative discusses a potential science story with his directly interested colleagues. If the latter decide to issue a report, a trained journalist from the University News Office is introduced for an interview. He writes the story and returns it for correction and criticism.

The completed story is distributed by the University News Office to local papers, Science Service and the national press services.

In this way an accurate account written in newspaper style is made generally available. A complete record of the scientist's connection with it also exists within the university. Of course the story as finally issued may be changed by individual newspapers. We have urged that any serious inaccuracy or distortion of a science report be corrected in a letter to the responsible editor. Such letters are frequently published, and in any case tend to decrease the further garbling of science news.

However, in our short experience there has been little occasion for such action. The stories which we have sponsored, scientifically authoritative and written in newspaper fashion, have appeared with remarkably little distortion, usually almost verbatim. By issuing such reports more promptly and comprehensively than newsmen alone could possibly prepare them, scientists rather than reporters can select the news which issues from science departments.

It is hoped that these procedures may possess some general interest and validity. Communications may be addressed to the committee secretary, Mrs. B. J. Bok, care of Harvard College Observatory, Cambridge, Mass.

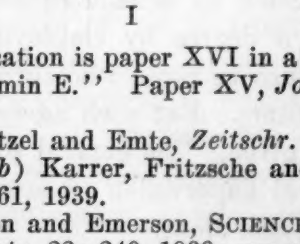
COMMITTEE ON PUBLIC RELATIONS OF SCIENCE, A.A.S.W., BOSTON AND CAMBRIDGE BRANCH

SPECIAL ARTICLES

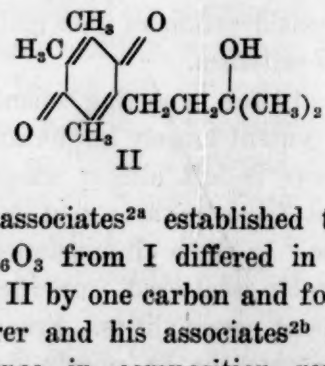
THE STRUCTURE OF THE RED OXIDATION PRODUCTS OF TOCOPHEROLS AND RELATED SUBSTANCES[1]

WHEN tocopherols, 2,2,5,7,8-pentamethyl-6-hydroxy chroman (I) and similar substances are oxidized under suitable conditions, the products are yellow para quinones (II).[2] When, however, silver nitrate or nitric acid is used as the oxidizing agent and the action of the reagent is prolonged, brilliant red solutions are obtained[2a, 2b, 3] and Furter and Meyer[4] have developed a photometric method of analysis for tocopherols based upon the reaction with nitric acid.

We have obtained the same red crystalline compound, m.p., 109–110°, from the chroman I using either silver nitrate or nitric acid as the oxidizing agent. Photometric examination of solutions of this substance and of solutions obtained from I by the procedure of Furter and Meyer shows that this red substance is responsible for the color developed in the latter case.

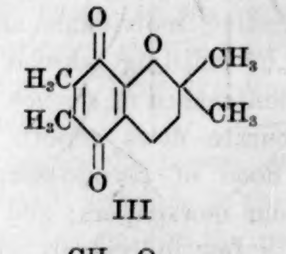


I

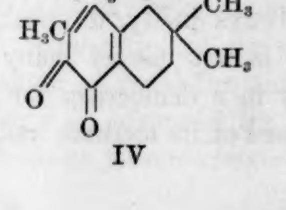


II

John and his associates[2a] established that the red compound $C_{13}H_{16}O_3$ from I differed in composition from the quinone II by one carbon and four hydrogen atoms; and Karrer and his associates[2b] showed that a similar difference in composition resulted when 2,5,7,8-tetramethyl-6-hydroxy chroman was converted into the analogous red compound $C_{12}H_{14}O_3$. Karrer also showed that the red compound was a quinone, and a tentative structure was proposed, which by analogy would become III when applied to the red



III



IV

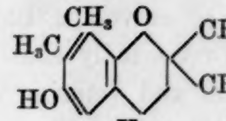
[1] This communication is paper XVI in a series on "The Chemistry of Vitamin E." Paper XV, *Jour. Org. Chem.*, 4: in press, 1939.

[2] (*a*) John, Dietzel and Emte, *Zeitschr. physiol. Chem.*, 257: 173, 1939; (*b*) Karrer, Fritzsche and Escher, *Helv. Chim. Acta*, 22: 661, 1939.

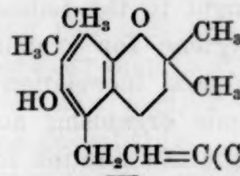
[3] Evans, Emerson and Emerson, SCIENCE, 88: 38, 1938.

[4] *Helv. Chim. Acta*, 22: 240, 1939; see also ref. 2*b*.

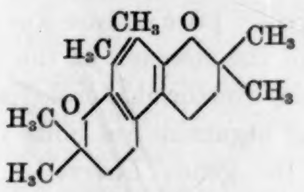
npound from I. The red substance, however, is not para quinone, but is an ortho quinone, and it has structure IV. The substance forms a phenazine, p. 151–152° with o-phenylene diamine and this enazine shows a strong greenish yellow fluorescence ultra-violet light, a property shown by the phenaes of the lapachol group of compounds, similar in ucture to IV.[5] That the methyl group in position 5 I is the group lost in the conversion of I to IV was own by the fact that the condensation products of ylo hydroquinone and isoprene (V, VI and VII), which the group in position 5 is not methyl, all gave same red compound IV, m.p. 109–110°, when subted to the action of nitric acid or silver nitrate.



V



VI



VII

A careful comparison of the absorption curves obined from IV with absorption curves of known quinones also leads unmistakably to the conclusion at the red compounds can not be para quinones, but e ortho quinones.

The red o-quinone from α-tocopherol is an oil. Unrtunately, although it reacts with o-phenylene diine, the phenazine is also an oil. However, soluons of this phenazine show the same strong greenish uorescence as is shown by the phenazine of IV, and ere can be little doubt but that the tocopherols are so converted into analogs of IV by nitric acid or lver nitrate.

The formation of red o-quinones is not confined to hydroxy chromans, but occurs also with 5-hydroxy umarans and other related substances. Catechol also roduces a red color in the Furter and Meyer reaction, fact which may be of importance in the examination f natural products by this method, since catechol erivatives are fairly common among natural products.

In these reactions, the mechanism is obscure, alough it appears that an alcohol, preferably a priary or secondary alcohol, must be used as the solvent, and the results indicate that the alcohol is probably a reagent as well as a solvent.

Full experimental details of this work will be published elsewhere.

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Willa B. Irwin
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School of Chemistry,
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[5] Hooker, *Jour. Chem. Soc.*, 63: 1376, 1893.

APPEARANCE OF FERMENTABLE POLYSACCHARIDE IN THE BLOOD AND A SIMPLE METHOD FOR ITS DETECTION[1]

Almost 40 years ago Besançon and Griffon,[2] Huber,[3] Neufeld[4] and Wadsworth[5] noted that certain bacteria grow more abundantly in the sera obtained from pneumonia patients than in normal sera. When inoculated with pneumococci, a voluminous white precipitate is obtained, while normal sera develop only a slight cloudiness. E. C. Rosenow[6] and Longcope[7] showed that this is due not to bacteria and bacterial debris, as was previously supposed, but to the production of unusually large quantities of acid which precipitate the serum proteins. Longcope noted this phenomenon in sera from patients with pneumococcic and streptococcic infections, from cases of gonococcus endocarditis, acute articular rheumatism, chronic nephritis and uremia. He concluded that "there is . . . some substance which makes its appearance in the blood stream under certain conditions and from which the pneumococcus is capable of forming large quantities of acid." Until the present study was undertaken in 1934, no further work has appeared, and the literature contains scant reference to this very striking phenomenon.

The following simple procedure was adopted early in this work. One cc of the clear sterile serum is transferred to a small sterile test-tube. Serum from strongly hemolyzed blood should not be used. It is inoculated with one drop of an 18-hour culture of a *rapidly growing strain* of pneumococcus. It is then incubated at 37.5° C. The precipitation becomes apparent in about 12 hours; it reaches its maximum in about 36 hours. Normal sera become faintly cloudy. Sera from patients with abnormal states may become opalescent (+), almost opaque (++), opaque with small amount of precipitate (+++) or they may contain a voluminous precipitate (++++). In order to rule out

[1] This study was aided by grants from the Bartlett Memorial Fund and the Douglas Smith Foundation for Medical Research of the University of Chicago.

[2] F. Besançon and V. Griffon, *Ann. Inst. Pasteur*, 14: 449, 1900.

[3] F. O. Huber, *Centralbl. innere Med.*, 23: 417, 1902.

[4] F. Neufeld, *Zeit. Hyg. Infectionskrank.*, 40: 54, 1902.

[5] A. Wadsworth, *Jour. Med. Res.*, 10: 228, 1903.

[6] E. C. Rosenow, *Jour. Inf. Dis.*, 2: 280, 1904.

[7] W. T. Longcope, *Jour. Exp. Med.*, 7: 626, 1905.

any effect due to abnormal quantities of free sugar, it is advisable to determine the reducing sugar in the zinc hydroxide[8] filtrate prepared from 1 to 2 cc of serum. Results from sera which contain more than 125 mg of free sugar per 100 cc should be discarded.

The acids which are produced in normal sera can be accounted for entirely by the free sugar which is consumed. Growth of the organisms appears to stop when the sugar is used up; from 40 to 80 mg of lactic acid are produced. The average yield of lactic acid is 72 per cent.

Unlike normal sera, however, growth continues in positive (+++ or ++++) sera at an apparently undiminished rate after the free sugar is consumed, until a terminal acidity of about pH 5.5 is reached. *The quantity of lactic acid is always greater than can be obtained from the free sugar.* For example, a serum, which contained 104 mg of free sugar, yielded 233 mg of lactic acid. Approximately 75 mg of the acid were derived (by calculation) from the free sugar; 158 mg of lactic acid were therefore derived from some other source.

As has long been known, normal sera contain considerable quantities of protein-polysaccharides.[9-12] By using a standard technique[13] throughout (increase of reducing sugar after 6 hours of hydrolysis with acid), we have invariably obtained higher results in +++ and ++++ sera than in normal ones. None of the sera contain measurable quantities of glycogen. The polysaccharide content is not perceptibly decreased by the growth of the organisms in the normal serum, but large quantities may be rapidly removed in the serum in which precipitation is noted. The production of acids parallels the consumption of the hydrolyzable sugar. Our results therefore indicate that *the phenomenon is due to the presence of abnormal quantities of a polysaccharide which supports rapid growth and which is readily fermented by the pneumococcus.* It thus differs from the normally present polysaccharide, which is not apparently metabolized by the microorganism, since growth stops in normal sera when the free sugar is consumed.

Besides the conditions mentioned by Rosenow and by Longcope, the phenomenon can be noted in sera from many other diseases. We have most often observed it in acute bacterial infections which are associated with a sustained high temperature. Negative results were obtained from the majority of sera from chronic osteomyelitis. Of sera which were obtained from 9 patients with tuberculous infections, 5 we[re] negative. The polysaccharide appears also in t[he] serum in some conditions in which there is no dire[ct] evidence of an infection. It is present in the major[ity] of sera in acute nephritis, in about one half of t[he] sera from hypertension in pregnancy and in about o[ne] half of the sera taken during parturition in huma[n] subjects.

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DEPARTMENT OF MEDICINE,
UNIVERSITY OF CHICAGO

[8] M. Somogyi, *Jour. Biol. Chem.*, 86: 655, 1930.
[9] B. Glassmann, *Zeit. physiol. Chem.*, 158: 113, 1926.
[10] C. Rimington, *Biochem. Jour.*, 23: 430, 1929; *Nature*, 126: 882, 1930.
[11] H. Bierry, F. Rathery and Mlle. Levina, *Paris Medical*, 83: 137, 1932.
[12] L. F. Hewitt, *Biochem. Jour.*, 32: 1554, 1938.
[13] T. E. Friedemann, *Jour. Bact.*, 35: 527, 1938.

LISTERELLA FROM A PREMATURE BOVI[NE] FETUS

PREMATURE birth of calves in Bang's disease fr[ee] herds in Illinois has repeatedly caused concern on t[he] part of cattle owners and veterinarians. Recently [a] seven months-old bovine fetus from a Bang's disea[se] free herd was brought to the Laboratory of Ani[mal] Pathology and Hygiene for examination. Cultu[ral] examination and animal inoculation proved negati[ve] to *Brucella,* pyogenic organisms and mycoses. T[he] results of microscopic examination for *Tritrichomon[as] foetus* were negative. However, a gram positive o[r]ganism in apparently pure culture was isolated on liv[er] agar plates from the stomach of the fetus. The cu[l]tural, pathogenic, tinctorial, serologic and biochem[ical] characters of the organism are quite indistinguishab[le] from those of the genus *Listerella.* There was n[o] definite history of encephalitis in the herd in whi[ch] the fetus originated. Unfortunately, no study cou[ld] be made of the aborting cow since she was sold f[or] slaughter immediately after aborting.

The organism is a hemolytic gram-positive rod. I[t] is slightly motile in semisolid agar stabs and in hangi[ng] drop preparations. Acid, but no gas is produced i[n] dextrose, maltose, levulose, rhamnose, and salic[in]. Slight acid is produced in lactose and very slight ac[id] in inosite after ten days, while sucrose is not fermente[d]. A rabbit inoculated subcutaneously with the stoma[ch] contents of the calf fetus died ten days later, and t[he] organism was recovered from its heart blood. A rabb[it] and two chickens were inoculated intravenously and [a] guinea pig was inoculated intraperitoneally with [a] saline suspension of the organism. The rabbit di[ed] two days later, and the organism was recovered fr[om] the heart blood and brain. The guinea pig died [six] days after inoculation, and the micro-organism wa[s] recovered from both heart blood and brain. It ha[s] been recognized that ocular instillation of Listerel[la] cultures may cause a transitory conjunctivitis in dif[]ferent species of animals, and Julianelle and Pon[s1] suggest that the production of conjunctivitis in rabbi[ts]

[1] L. A. Julianelle and C. A. Pons, *Proc. Soc. Exp. Bi[ol.] and Med.*, 40: 362, 1939.

f value in the identification of *Listerella*. To deter- e if the organism under investigation could cause junctivitis a drop of a heavy suspension of the eria was placed in the eye of a rabbit and a guinea Two days later a severe conjunctivitis appeared oth animals. While the pathogenesis of this organ- is thus established, its abortifacient properties, if , are not established.

he results of agglutination tests are of particular rest. Julianelle and Pons[2] found two serological es of *Listerella* among the strains they studied. e I was composed of two rabbit and two human ins, while Type II comprised one strain each from le, sheep, goats, and man. The strain herein re- ted, when set up against antisera of these two es kindly furnished by Dr. Julianelle, was partially lutinated by the ruminant type antiserum in a titer -25, while with the rodent type antiserum it was pletely agglutinated at a titer of 1–1600. Appar- y the serological and host relations of *Listerella* ins are more complex than heretofore believed.

ones and Little[3] first mentioned the relation of erella to bovine encephalitis. Olafson, according Udall,[4] also recognized the spontaneous disease in le and sheep in New York State, while more than a r ago encephalitis and encephalomyelitis in both le and sheep associated with *Listerella* were recog- d in Illinois.[5] More recently Biester and Schwarte[6] orted spontaneous bovine listerellosis in Iowa. ing the past few months two unreported outbreaks attle and one unreported outbreak in sheep have e to our attention, but so far as we know the sence of *Listerella* has not been reported heretofore he tissues of a prematurely born calf. However, n[7] reported Listerella infection in a day-old infant a prematurely born child. His findings and our observation suggest the desirability of further ly to determine the significance of *Listerella* in the mature bovine fetus. The possible extended role of pathogen heretofore regarded as an encephalitic /or encephalomyelitic factor in cattle is further gested by an apparent artificially induced abortion a healthy pregnant heifer. This heifer originated small Bang's disease-free herd, and proved nega- to the agglutination test for Bang's disease im- liately preceding exposure to *Listerella*. Ten days owing intravenous inoculation of the *Listerella* culture isolated from the bovine fetus described herein, abortion occurred. From the aborted fetus, *Listerella* was regained in pure and abundant culture from the brain stem, cerebrum, heart blood, thymus gland and bone marrow.

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SOLUTE TRANSPORT IN PLANTS

THE problem of water and solute movement in plants periodically appears for reconsideration. Though work of Strasburger, Dixon, Ursprung, Renner and others, resulting in the cohesion theory of water movement, and its corollary, the upward transport of mineral nutrients in the transpiration stream, satisfied many, Curtis contends that salts ascend the stem in the phloem, and Priestley, Peirce and others question the cohesion mechanism as explaining the rise of water.

Work by Maskell and Mason[1] and Clements and Engard[2] clearly indicated upward transport of salts in the xylem. Even more convincing are results by Stout and Hoagland[3] and Bennett and Snell[4] with radioactive elements showing that salts absorbed by the roots ascend unringed as well as ringed stems in the xylem.

Though described years ago, certain details of the cohesion mechanism continue to elude clear interpretation. Micro-dissection studies conducted in connection with the translocation of herbicides in plants have thrown light on a number of obscure points. When transpirational water loss exceeds absorption by the roots, the water balance soon becomes negative, and hydrostatic pressure in the xylem lowers until, crossing the zero point, a state of tension is developed in the conducting tracts. When in this state of tension, liquid, contrary to popular opinion, displays tensile strength as would a solid. And the degree of tension may reach many atmospheres and the state persist for long periods.

In the tensile condition xylem sap is virtually a superheated liquid in a metastable state, and the stability of the system depends upon the fact that there are no unwet surfaces upon which the vapor phase may become initiated. As Dixon, Askenasy and others have shown, this situation may be demonstrated in a strictly physical system and depends not upon the form

[1] E. J. Maskell and T. G. Mason, *Ann. Bot.*, 43: 205, 1929.

[2] H. F. Clements and C. J. Engard, *Plant Physiol.*, 13: 103, 1938.

[3] P. R. Stout and D. R. Hoagland, *Amer. Jour. Bot.*, 26: 320, 1939.

[4] J. P. Bennett and A. Snell, private communication.

or structure of plant cells but upon the properties of water.

In the dissection experiments made by the author, both intact and cut stems of plants growing in soil tubes were studied under the dissecting binocular. When a stem with tensile sap columns is cut, air immediately enters all the severed vessels, and the liquid columns recede from the cut end. However, if the deficit is not excessive, menisci in the smaller vessels soon reverse their movement, and these tubes are refilled. Meanwhile liquid in the large vessels continues to recede, supplying water for the refilling ones as well as that lost by transpiration. As expected from laws of capillarity, competition for water by various-sized tubes results in readjustment, the larger vessels losing and the smaller gaining. As the larger ones become depleted, successively smaller elements lose their contents until finally all conductors are sucked dry. During the various stages of readjustment, and particularly immediately following cutting, columns of sap, water vapor and air may be seen moving in opposite directions in the xylem—a fact that seems clear in terms of capillary action, yet one that has confused many students of translocation.

As might further be predicted, when tensile sap columns in intact xylem vessels are jarred or deformed by flattening the elements with a rounded instrument, they break and the vapor columns expand until they reach the limits of the elements in which they are formed, or until the pressure rises somewhat above the zero point. This proves the tensile state of the water columns, for the vapor phase would not continue to expand if the pressure was above that of saturated water vapor at the temperature of the experiment. As in the cut stem, if vapor is formed in several vessels and the stem is not further disturbed readjustment follows with the vapor columns in the smaller elements contracting and those in the larger continuing to expand. That the columns are water vapor and not air is proved by their rapid collapse under increased pressure. The forcing of air into solution by the surface forces of the bubble would require much more time, as is proved by similar tests with the Askenasy apparatus.

Though the above experiments provide satisfactory evidence of the existence and characteristics of tensile sap columns in plants, the old experiment on subaqueous transpiration performed by Dixon in 1897 has never been explained on a purely physical basis. As recently reported,[5] Smith, Dustman and Shull[6] failed to account for this phenomenon, for Dixon was able to obtain a rise of eosin after saturating his test shoots by immersion for twenty-four hours.

[5] H. H. Dixon, *Bot. School of Trinity Coll., Dublin, Notes*, 4: 319, 1938.

[6] F. Smith, R. B. Dustman and C. A. Shull, *Bot. Gaz.*, 91: 395, 1931.

The fact, recently confirmed by the writer, that aqueous transpiration occurs only in the light, suggested the following explanation: The pressure mechanism of solute transport in the phloem req the osmotic absorption of water from the xylem regions of active synthesis. Assimilates in sol move to regions of utilization where water is lo the xylem or to expanding tissues.

Though a recirculation of water in the xylem not explain the rise of eosin in subaqueous water ments, there are other places that the water might All growing cells of the cambium or expanding le of the shoot tips require water. Some liquid m also be lost to the intercellular spaces of leaves w often show a partial flooding. Uptake of water f the xylem would in all cases be a function of pl activity rather than a secretory process of mesop cells as originally suggested by Dixon.

To substantiate these deductions, the writer has cently shown that when experiments on subaqu water movement are set up using forked branches *Syringa vulgaris,* ringing one of the branches favor eosin movement up the unringed branch, es cially if there is an appreciable portion of bare s below the fork to provide an adequate differentia living tissue to consume the moving assimilates. T results indicate that the rise of sap in the non-li conduits of the xylem can be accounted for on pu physical grounds, and they explain the single excep made by Dixon to this assumption. On the other h they reemphasize the complexity of the over-all pr esses of translocation and point out the essential played by living cells and tissues.

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